Contract V81621, West Levee Alignment Study,
Craney Island, Norfolk Harbor, Norfolk,
Virginia (Contract No. DACW-65-81-D-0020)

SCHNABEL ENGINEERING ASSOCIATES
P. C.
CONSULTING GEOTECHNICAL ENGINEERS

January 22, 1982

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Attn: Mr. Jack G. Starr
Chief, Engineering Division

Subject: Contract V81621, West Levee Alignment Study, Craney Island, Norfolk Harbor, Norfolk, Virginia (Contract No. DACW-65-81-D-0020)

Gentlemen:

Submitted herewith are four copies of our report for the above referenced project. This report covers the subsurface investigation, laboratory testing, and engineering analysis made in accordance with our agreement dated December 22, 1981.

Scope

Our scope of services included: (A) Subsurface Field Investigation, (B) Layout and Inspection of Field Investigation, (C) Soil Laboratory Testing, and (D) a Geotechnical Engineering Analysis. The geotechnical engineering analysis included the study of test borings, geological, soil test and groundwater data to develop the following:

1. An estimated geologic profile along the levee.

2. Shear strength parameter recommendations.

No construction inspection, stability analysis, quantity estimates, or detailed plans and specifications were included in this study.

Conclusions and Recommendations

Based on the information contained in this report, the following summary of conclusions and recommendations is presented:

1. Levee fill extends to depths of 23 to 74 ft in the study area and is underlain by a soft, highly plastic marine clay (Stratum B) having low to moderate shear strength.

2. Similar strength values were obtained for both triaxial testing and vane shear testing within the clay stratum, with vane tests slightly higher as expected. The strength of the clay formation appears to increase with depth.

3. We believe the shear strength of the marine clay can best be characterized by utilizing an undrained strength of 350 to 400 psf above El -65, and a value of 550 to 600 psf below this elevation.

Site Description, Proposed Construction and General Subsurface Conditions

Craney Island is a slurry disposal area for the U. S. Army Corps of Engineers dredging operations in the vicinity of the Norfolk Harbor. This disposal area is ringed by a levee approximately 15 to 25 feet above sea level, which is gradually becoming filled. The levee surrounding the disposal area could potentially be raised to increase the life expectancy of this site. The purpose of this study is to determine subsurface conditions and perform laboratory testing to provide appropriate strength data so that a stability analysis may be performed for the raised levee. The field investigation and laboratory test program were developed by your office.

Seven test borings were drilled by Ayers and Ayers, Inc., Richmond, Virginia, under our inspection in December, 1981 and January, 1982. Test boring logs are included in Enclosure 2 with test boring locations shown on Sheet 1. An estimated subsurface profile, Sheet 2, is also included in the enclosure. The test borings indicate the following generalized soil strata underlie the site to the depths investigated:

Stratum A:	From ground surface to depths of 23 to 74 ft	Tan, brown or gray fine to coarse sand FILL with variable amounts of silt and clay (SP, SM and SC); very loose to very compact density (N = 3 to 50)
Stratum B:	Below Stratum A to maximum depth of penetration, 115 ft	Gray, CLAY, trace fine sand with shell fragments (CH); soft consistency (N = WOR to 8)
Stratum C:	Below Stratum B to maximum depth of 113 ft in Boring DH-7	Dark gray fine sandy CLAY with wood fragments (CL); soft to medium consistency (N = WOR to 6); and gray fine to medium SAND, trace clay (SC); very loose density (N = WOR)

Stratum D:	Below Stratum C in Boring DH-7 to the maximum depth of penetration 115 ft	Gray-green fine to medium SAND, trace silt (SM); compact density (N = 45)

The above N values indicate the low and high Standard Penetration Test resistances encountered in a particular layer as determined from the number of blows required to drive a 2 inch O.D., 1-3/8 inch I.D. sampling spoon one foot using a 140 pound hammer falling 30 inches. This test is conducted after seating the sampler six inches in the bottom of the hole according to ASTM D-1586.

Stratum A soils are a sandy fill with variable amounts of silt and clay. This material was probably brought to the site from local borrow areas to build the existing levee. Stratum B soils appear to be natural marine and estuarine clays deposited by the lower James and Nansemond River Systems at Hampton Roads.

Stratum C soils represent transition clays and sands between the marine clays and the Miocene age, Yorktown Formation. Stratum D soils are probably the upper part of the Yorktown Formation.

Groundwater was encountered at depths of 5 to 7 feet in all borings, corresponding to elevations of +2 to sea level. Long-term water level readings indicated all borings dry at the shallower cave depths of 1.2 to 4.5 ft. Recorded groundwater levels appear to reflect the phreatic surface within the levee embankment.

Laboratory and In situ Testing

Twelve undisturbed tube samples were tested in our soils laboratory with results included in the Summary of Soil Laboratory Tests of Enclosure 1. Classifications are in accordance with the Unified Soils System, ASTM D-2487.

Stratum A: Brown fine to coarse sand with clay layers and shell fragments (SP)

One tube sample was obtained within Stratum A. A fairly high natural dry density of 95 pcf was measured at a natural moisture content of 22.3%. The Plasticity Index was 36 indicating moderate plasticity for the clay layers. Only about 5% material by weight within the sandier zones passed the No. 200 sieve. These soils should be considered as poorly graded due to the clay layers present.

Stratum C: Dark gray fine sandy clay with wood fragments (CL)

One vane shear test was performed within this stratum. The undrained vane shear strength was found to be S_u = 3450 psf as shown in Enclosure 1. This value is much higher than those encountered in Stratum B, most likely due to the increased sand content in this stratum.

Stratum B: Gray clay, trace fine sand (CH)

Natural density and moisture was measured for each sample within this unit. The natural dry densities were low ranging from 51 to 66 pcf. Natural moisture contents often approached liquid limit values indicating a relatively soft material. Values of 43 to 82% were recorded. The Plasticity Index varied from 34 to 68, indicating moderate to high plasticity as expected for this material. A maximum of only 5% material by weight was retained on the No. 200 sieve, indicating predominately fine-grained material. Liquidity Indices were found to range from 0.19 to 1.12. Based on the high average value of 0.82 and sensitivity of the material it is estimated that this formation is normally consolidated.

Eleven unconsolidated undrained (UU) triaxial tests were performed. Triaxial test curves are presented in Enclosure 1. These tests were performed in general accordance with ASTM D-2850. Sample diameters were approximately 2.8 inches for all test specimens except DH-2/89' and DH-6/34' which had an approximate diameter of 1.9 inches. All test specimens had height to diameter ratios of 2 to 3. All tests except DH-2/89' were performed at about 0.05 in/min corresponding to a strain rate of about 1%/min. The strain rate for DH-2/89' was about 0.8%/min, Confining pressures were determined based on approximate effective overburden pressures calculated from laboratory and test boring data.

The following is a summary of undrained shear strengths obtained during this investigation:

Boring/Depth	Apparent Cohesion, c
DH-2/71-73'	710 psf
DH-2/89-91'	570 psf
DH-3/44-46'	390 psf
DH-3/64-66'	470 psf
DH-3/84-86'	740 psf
DH-5/44-46'	120 psf
DH-5/69-71'	310 psf
DH-5/84-86'	660 psf
DH-6/34-36'	430 psf
DH-6/79-81'	550 psf
DH-6/99-101'	420 psf

As indicated above, values of 120 to 740 psf were obtained. The average value is about c = 490 psf. The undrained shear strength typically tends to increase with depth.

Eight vane shear tests were also performed in Stratum B as indicated on the boring logs. Vane shear tests are shown plotted in Enclosure 1. These tests were performed in accordance with the suggested Sprague & Henwood Vane Test Procedure using a 2" (5.08 cm) vane with an area ratio of 13.4%. Strain rates varied from about 1 to 1.5 degrees per minute. The following is a summary of the undisturbed undrained shear strength as measured by this procedure:

Boring/Depth	Undrained Vane Shear Strength (psf)
DH-1/76-78'	S_u = 2000
DH-1/84-86'	S_u = 1250
DH-1/94-96'	S_u = 1300
DH-4/34-36'	S_u = 450
DH-4/59-61'	S_u = 650
DH-4/84-86'	S_u = 750
DH-7/44-46'	S_u = 475
DH-7/69-71'	S_u = 600

As indicated above values of 450 to 2000 psf were obtained. The average value is about 935 psf. Remolded strengths varied from 190 to 1000 psf with an average value of about 535 psf. Sensitivity was calculated from the ratio of undisturbed to remolded strengths. The sensitivity of the Stratum B clays ranged from 1.3 to 2.4. These values are relatively low for clays of this plasticity.

Evaluation of Results

As expected, values obtained from vane tests were slightly above those obtained by triaxial testing. The vane shear strengths may be related to the triaxial shear strengths using a correction factor after Bjerrum. This factor is based on the Plasticity Index of the clay, and for Stratum B soils may be taken as 0.8. Utilizing this correction factor the vane shear strength parameters are very close to the corresponding triaxial test values except in DH-1 where vane shear testing indicates high strength. Utilizing both laboratory results and corrected field vane results we believe the Stratum B clays can best be characterized by using an undrained strength of 350 to 400 psf above El -65 and 550 to 600 psf below this elevation.

General

We have prepared this report in accordance with generally accepted geotechnical engineering practice and make no other warranties, either expressed or implied, as to the professional advice provided under the terms of this agreement and included in this report.

Soil samples will be held until March 1, 1982, and will then be disposed of unless further disposition is requested.

We appreciate the opportunity to be of service for this project. Please do not hesitate to contact us if clarification is needed for any aspect of this report.

Very truly yours,

SCHNABEL ENGINEERING ASSOCIATES, P.C.

Ann M. Samford
Senior Staff Engineer

Raymond A. DeStephen, P.E.
Commonwealth of Virginia

AMS:RAD:maj

Enclosures

(1) Summary of Soil Laboratory Tests
Triaxial Compression Test Curves (11)
Field Vane Shear Test Curves (8)

(2) Subsurface Exploration Data
General Notes for Test Boring Logs
Identification of Soil Samples
Test Boring Logs, DH-1 through DH-7
Test Boring Location Plan, Sheet 1
Estimated Subsurface Profile, Sheet 2

Enclosure 1
Contract V81621

SUMMARY OF SOIL LABORATORY TESTS

Boring No.	Sample Depth / Elev.	Sample Type	Description of Soil Specimen	Stratum Designation	Natural Density pcf		Atterberg Limits			Natural Moisture (%)	% Passing No. 200 Sieve	Specific Gravity	Remarks
					Wet	Dry	LL	PL	PI				
DH-1	76-78' / -68	*	Clay, trace fine sand, wet - gray (CH)	B	-	-	-	-	-	-	-	-	See Vane Shear Curve
DH-1	84-86' / -76	*	Clay, trace fine sand, wet - gray (CH)	B	-	-	-	-	-	-	-	-	See Vane Shear Curve
DH-1	94-96' / -86	*	Clay, trace fine sand, wet - gray (CH)	B	-	-	-	-	-	-	-	-	See Vane Shear Curve
DH-2	41-43' / -35	Tube	Fine to coarse sand with clay layers and shell fragments-brown (SP)	A	116	95	52	16	36	22.3	5	2.74	-
DH-2	71-73' / -65	Tube	Clay, with shell fragments-gray (CH)	B	102	66	64	25	39	54.7	99	2.62	See Triaxial Test Curve
DH-2	89-91' / -83	Tube	Clay - gray (CH)	B	100	61	69	32	37	63.4	100	2.68	See Triaxial Test Curve
DH-3	44-46' / -36	Tube	Clay-gray (CH)	B	96	55	72	29	43	75.4	99	2.72	See Triaxial Test Curve

Notes:
1. Soil tests in accordance with applicable ASTM Standards.
2. Soil classifications in accordance with Unified Soil Classification System.
3. Key to abbreviations: LL=Liquid Limit; PL=Plastic Limit; PI=Plasticity Index.
4. Soil Tests were conducted by B. Frey, L. Clark.
5. Visual description based on nearest jar sample.

Enclosure 1
Contract V81621

SUMMARY OF SOIL LABORATORY TESTS

Boring No.	Sample Depth / Elev.	Sample Type	Description of Soil Specimen	Stratum Designation	Natural Density pcf		Atterberg Limits			Natural Moisture (%)	% Passing No.200 Sieve	Specific Gravity	Remarks
					Wet	Dry	LL	PL	PI				
DH-3	64-66' / -56	Tube	Clay-gray (CH)	B	94	53	94	26	68	79.4	100	2.75	See Triaxial Test Curve
DH-3	84-86' / -76	Tube	Clay, with shell fragments - gray (CH)	B	95	52	76	26	50	82.2	99	2.69	See Triaxial Test Curve
DH-4	34-36' / -27	*	Clay, trace fine sand, wet - dark gray (CH)	B	-	-	-	-	-	-	-	-	See Vane Shear Curve
DH-4	59-61' / -52	*	Clay, trace fine sand, wet - dark gray	B	-	-	-	-	-	-	-	-	See Vane Shear Curve
DH-4	84-86' / -77	*	Clay, trace fine sand, wet - dark gray	B	-	-	-	-	-	-	-	-	See Vane Shear Curve
DH-5	44-46' / -37	Tube	Clay - gray (CH)	B	98	58	80	30	50	67.8	100	2.65	See Triaxial Test Curve
DH-5	69-71' / -62	Tube	Clay, trace fine sand, with shell fragments-gray (CH)	B	93	51	88	33	55	83.1	97	2.65	See Triaxial Test Curve

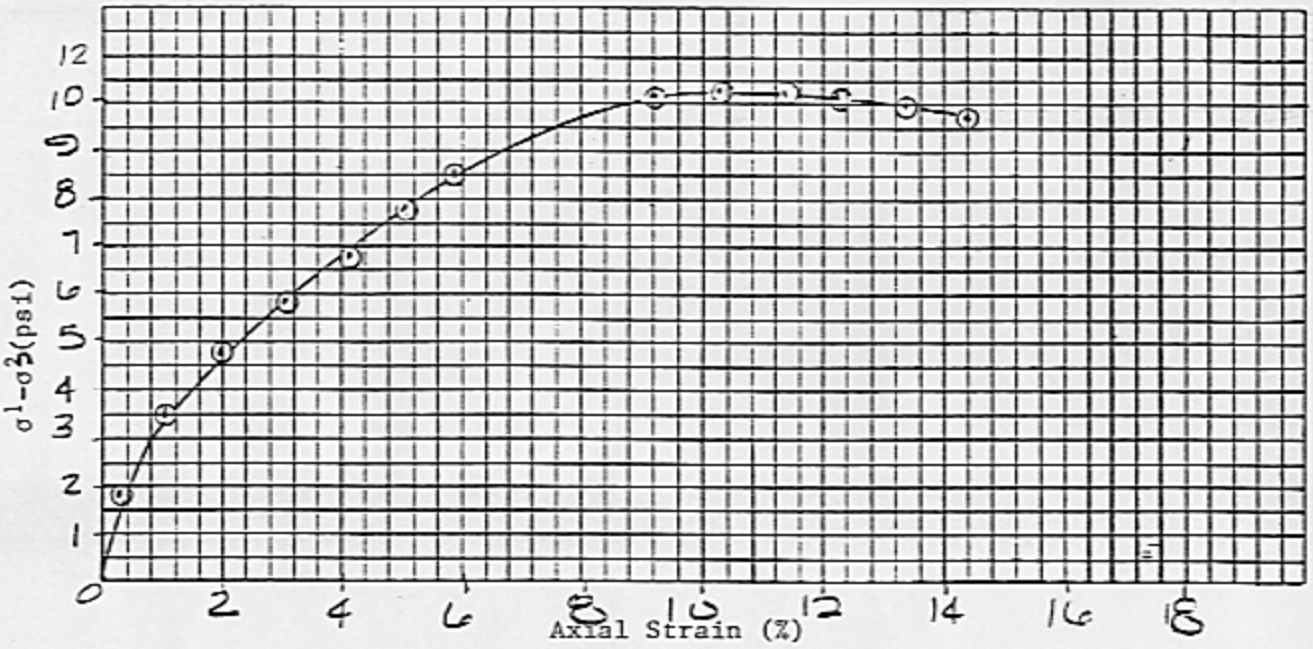
Notes:
1. Soil tests in accordance with applicable ASTM Standards.
2. Soil classifications in accordance with Unified Soil Classification System.
3. Key to abbreviations: LL=Liquid Limit; PL=Plastic Limit; PI=Plasticity Index.
4. Soil Tests were conducted by B. Frey, L. Clark.
* 5. Visual description based on nearest jar sample.

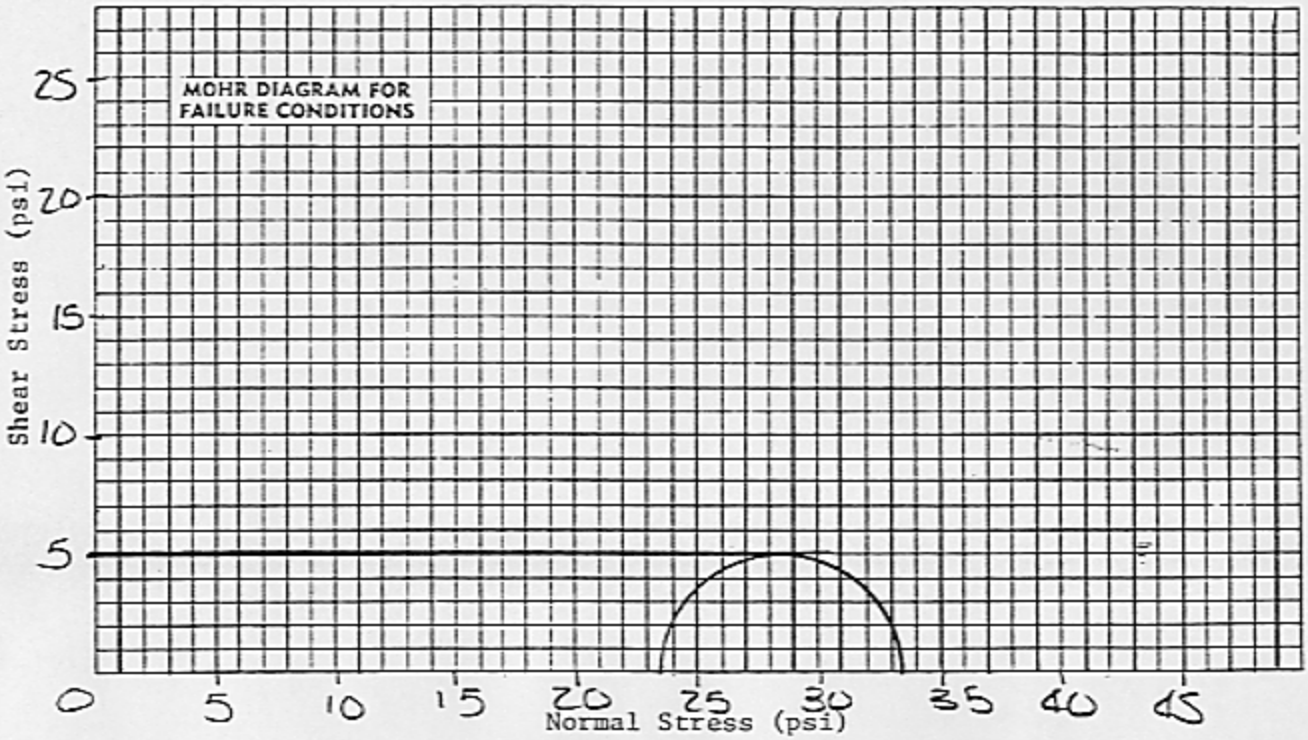
Enclosure 1
Contract V81621

SUMMARY OF SOIL LABORATORY TESTS

Boring No.	Sample Depth / Elev.	Sample Type	Description of Soil Specimen	Stratum Designation	Natural Density pcf		Atterberg Limits			Natural Moisture (%)	% Passing No.200 Sieve	Specific Gravity	Remarks
					Wet	Dry	LL	PL	PI				
DH-5	84-86' / -77	Tube	Clay, trace fine sand - gray (CH)	B	94	66	84	33	51	42.7	100	2.70	See Triaxial Test Curve
DH-6	34-36' / -28	Tube	Clay, trace fine sand, with shell fragments - gray (CH)	B	103	63	77	43	34	64.6	95	2.71	See Triaxial Test Curve
DH-6	79-81' / -73	Tube	Clay - gray (CH)	B	94	52	83	30	53	81.0	99	2.73	See Triaxial Test Curve
DH-6	99-101' / -93	Tube	Clay, with shell fragments - gray (CH)	B	99	58	77	29	48	69.2	100	2.68	See Triaxial Test Curve
DH-7	44-46' / -39	*	Clay, trace fine sand, wet - gray (CH)	B	-	-	-	-	-	-	-	-	See Vane Shear Curve
DH-7	69-71' / -64	*	Clay, trace fine sand, wet - gray (CH)	B	-	-	-	-	-	-	-	-	See Vane Shear Curve
DH-7	100-102' / -95	*	Fine sandy clay, moist - dark gray (CL)	C	-	-	-	-	-	-	-	-	See Vane Shear Curve

Notes:
1. Soil tests in accordance with applicable ASTM Standards.
2. Soil classifications in accordance with Unified Soil Classification System.
3. Key to abbreviations: LL=Liquid Limit; PL=Plastic Limit; PI=Plasticity Index.
4. Soil Tests were conducted by B. Frey, L. Clark.
* 5. Visual description based on nearest jar sample.





DESCRIPTION AND CLASSIFICATION OF SOIL SPECIMEN TESTED

CLAY, TRACE FINE SAND, GRAY (CH)

STRATUM: B

Key	Boring No.	Sample Depth, ft.	Lateral Pressure	Moist. Cont., % Initial	Moist. Cont., % Final	Density, pcf Dry	Density, pcf Wet
⊙	DH-2	71-73	23.6	54.7		66	102

SCHNABEL ENGINEERING ASSOCIATES
SOIL MECHANICS LABORATORY

TRIAXIAL COMPRESSION TEST

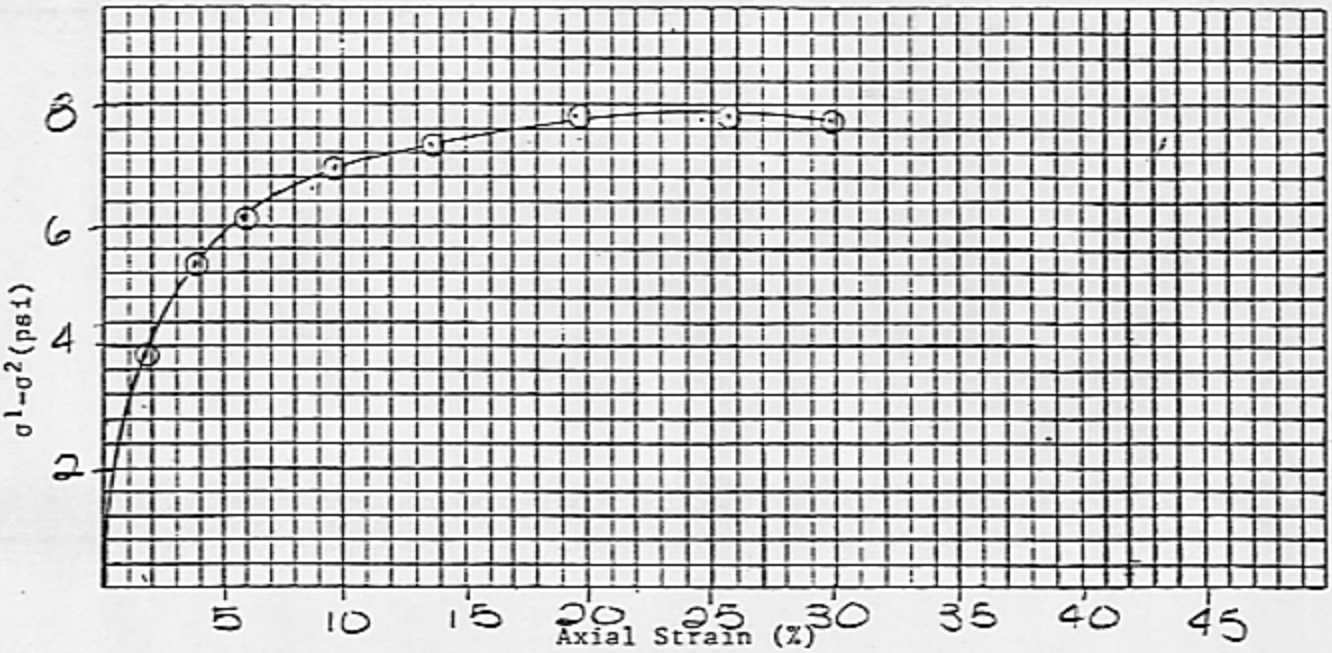
TYPE OF TEST: UNCONSOLIDATED UNDRAINED

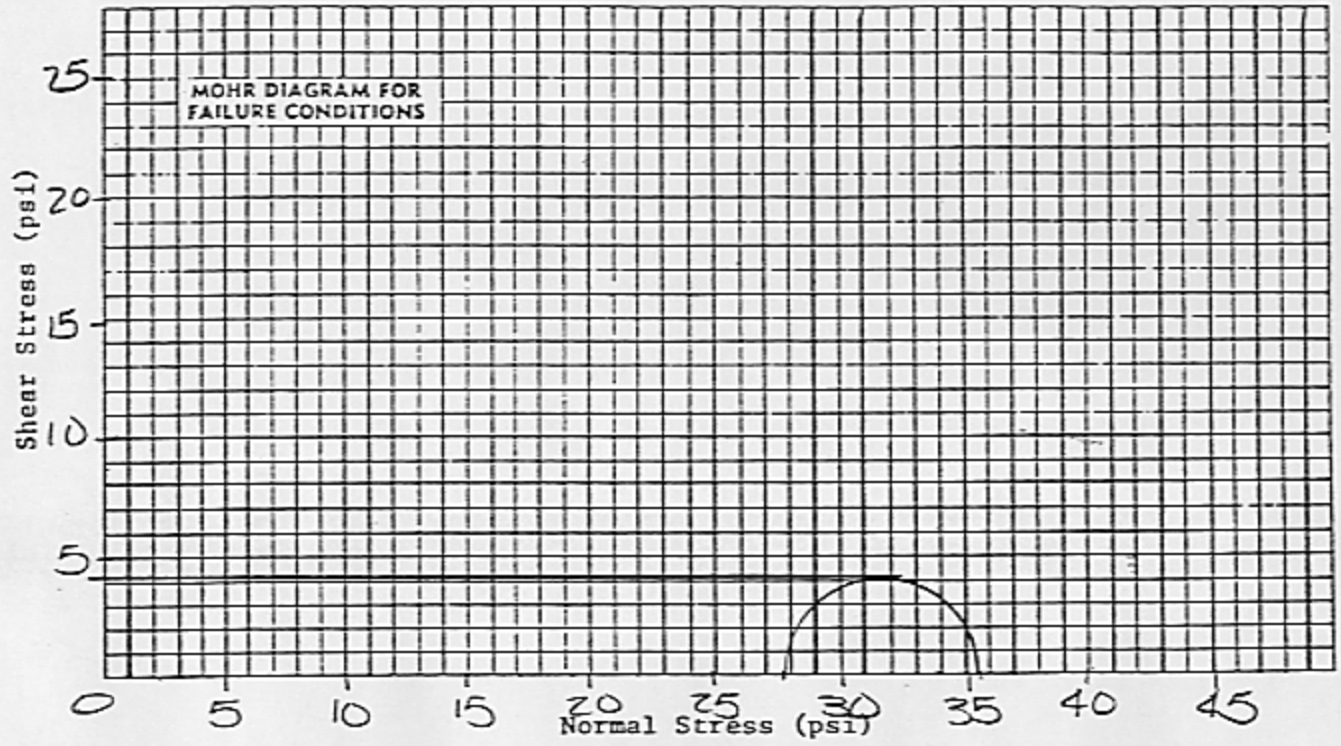
RATE OF SHEAR: 0.05 in/min

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: V81621





DESCRIPTION AND CLASSIFICATION OF SOIL SPECIMEN TESTED

CLAY, TRACE FINE SAND, GRAY (CH)

STRATUM: B

Key	Boring No.	Sample Depth, ft.	Lateral Pressure	Moist. Cont., % Initial	Moist. Cont., % Final	Density, pcf Dry	Density, pcf Wet
⊙	DH-2	89-91	27.8	63.4		61	100

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TRIAXIAL COMPRESSION TEST

TYPE OF TEST: UNCONSOLIDATED UNDRAINED

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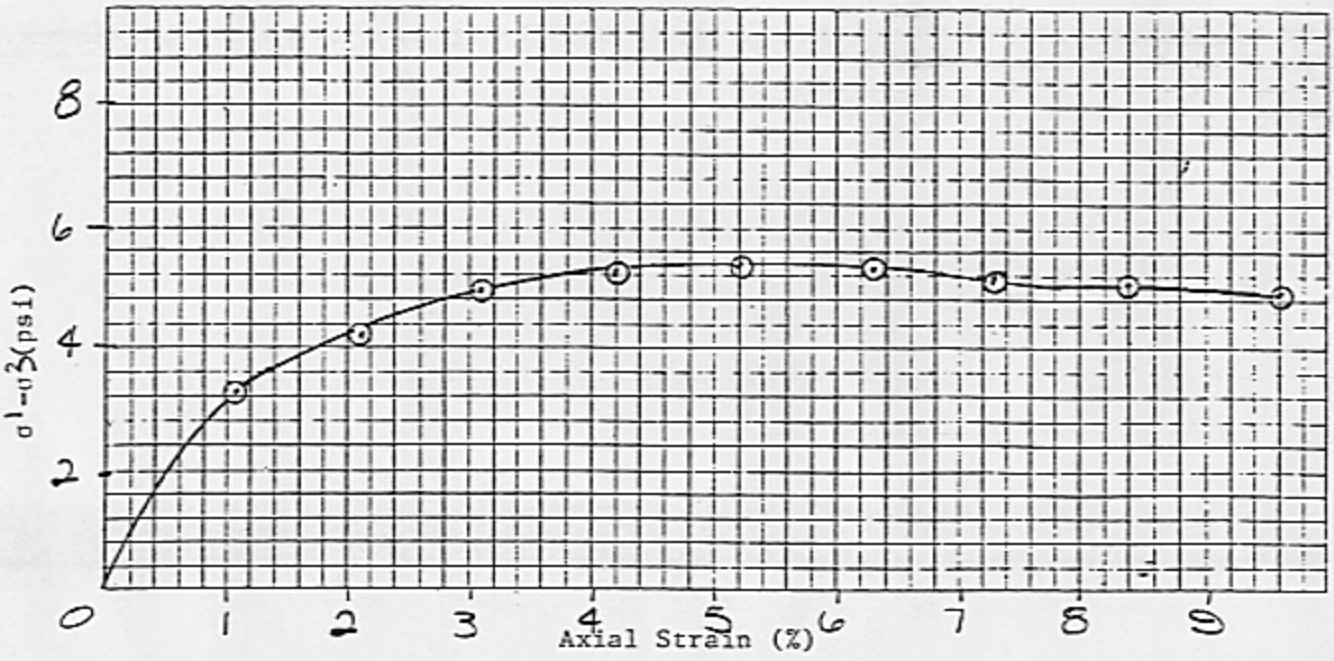
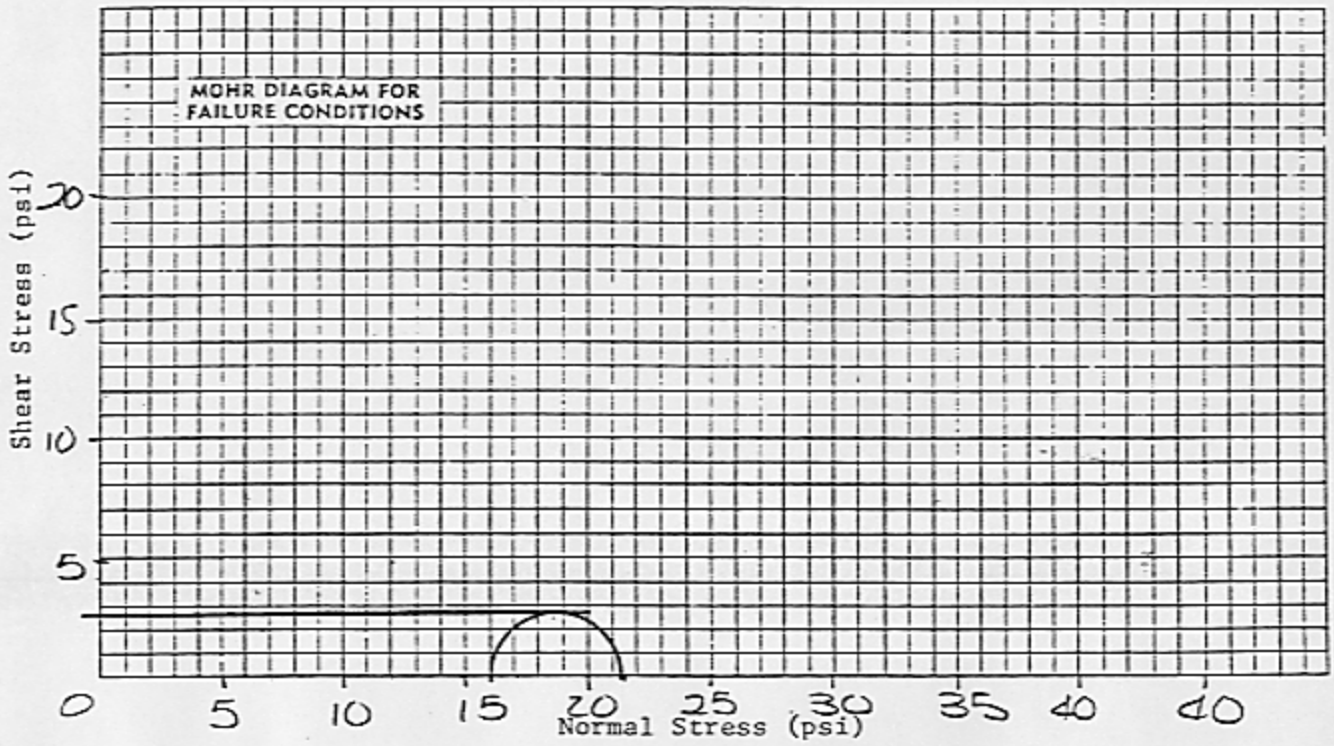
PROJECT: CRANEY ISLAND
NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: V81621





DESCRIPTION AND CLASSIFICATION OF SOIL SPECIMEN TESTED

CLAY, TRACE FINE SAND, GRAY (CH)

STRATUM: B

Key	Boring No.	Sample Depth, ft.	Lateral Pressure	Moist. Cont., % Initial	Moist. Cont., % Final	Density, pcf Dry	Density, pcf Wet
⊙	DH-3	44-46'	16.0	75.4		55	96

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TRIAXIAL COMPRESSION TEST

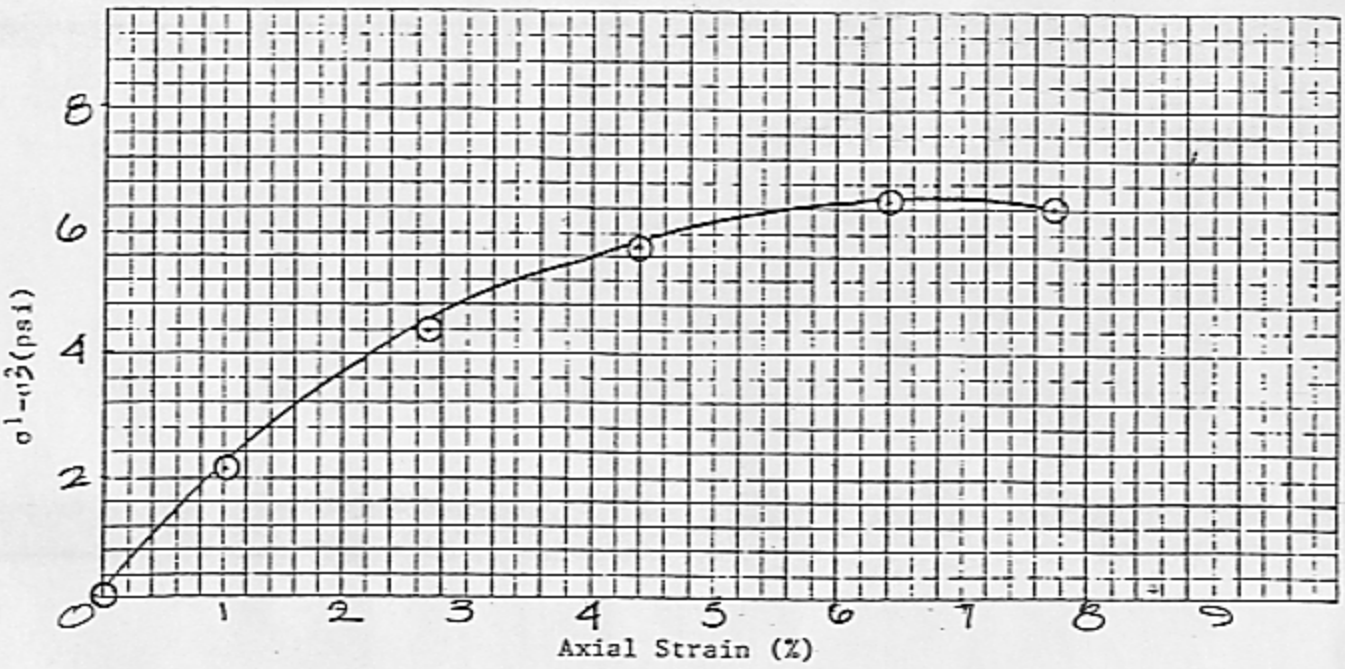
TYPE OF TEST: UNCONSOLIDATED UNDRAINED

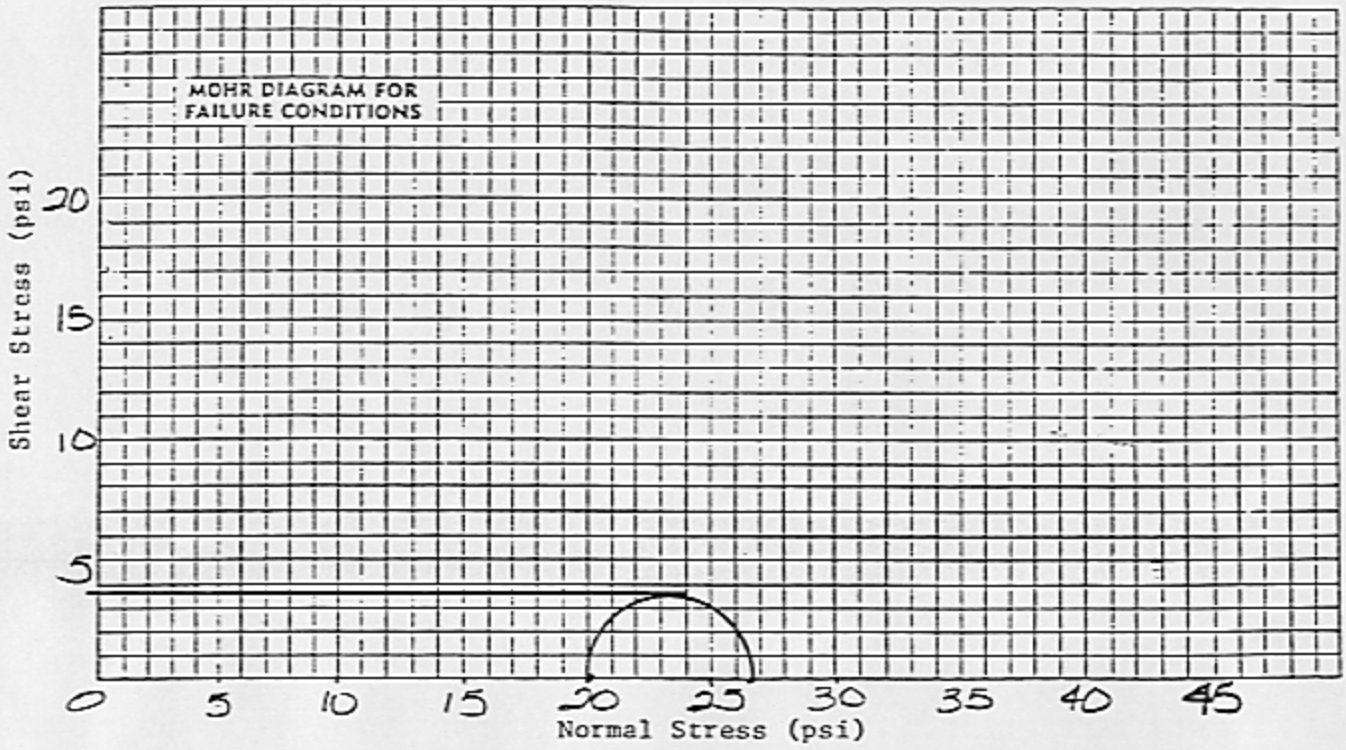
RATE OF SHEAR: 0.05 in/min.

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: V81621





DESCRIPTION AND CLASSIFICATION OF SOIL SPECIMEN TESTED

CLAY, TRACE FINE SAND, GRAY (CH)

STRATUM: B

Key	Boring No.	Sample Depth, ft.	Lateral Pressure	Moist. Cont., % Initial	Moist. Cont., % Final	Density, pcf Dry	Density, pcf Wet
0	DH-3	64-66	20psi	79.4	.	53	94

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SOIL MECHANICS LABORATORY

TRIAXIAL COMPRESSION TEST

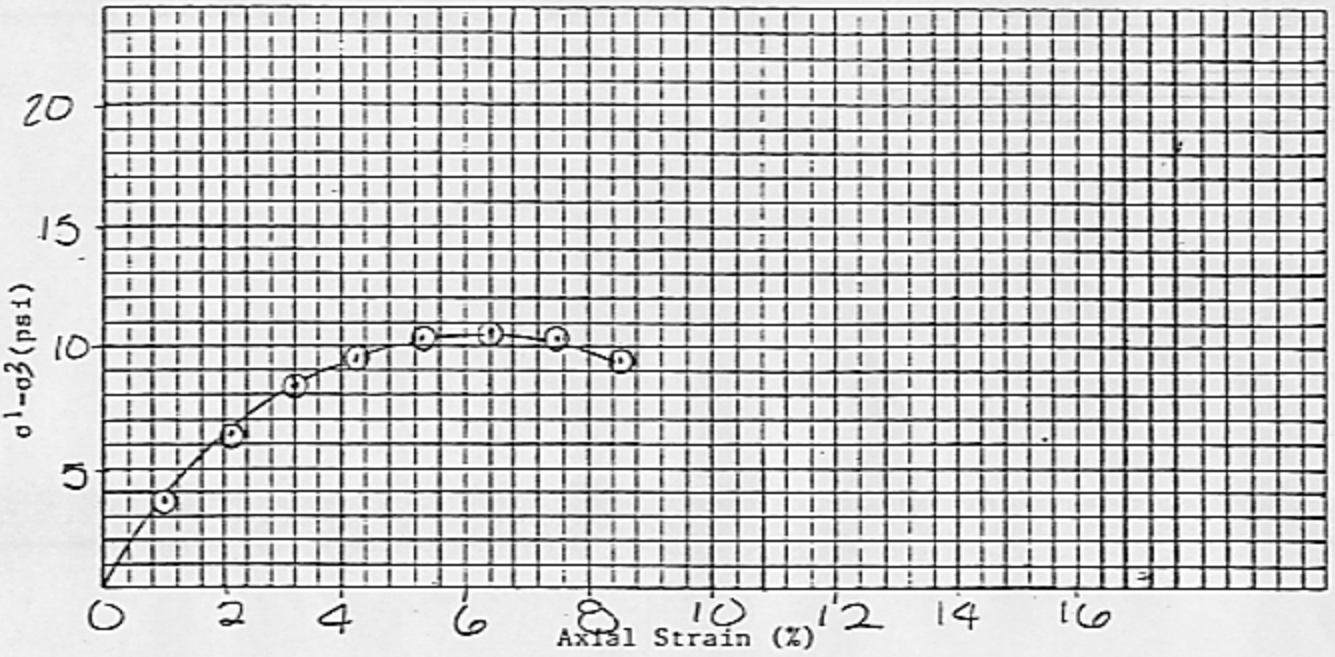
TYPE OF TEST: UNCONSOLIDATED UNDRAINED

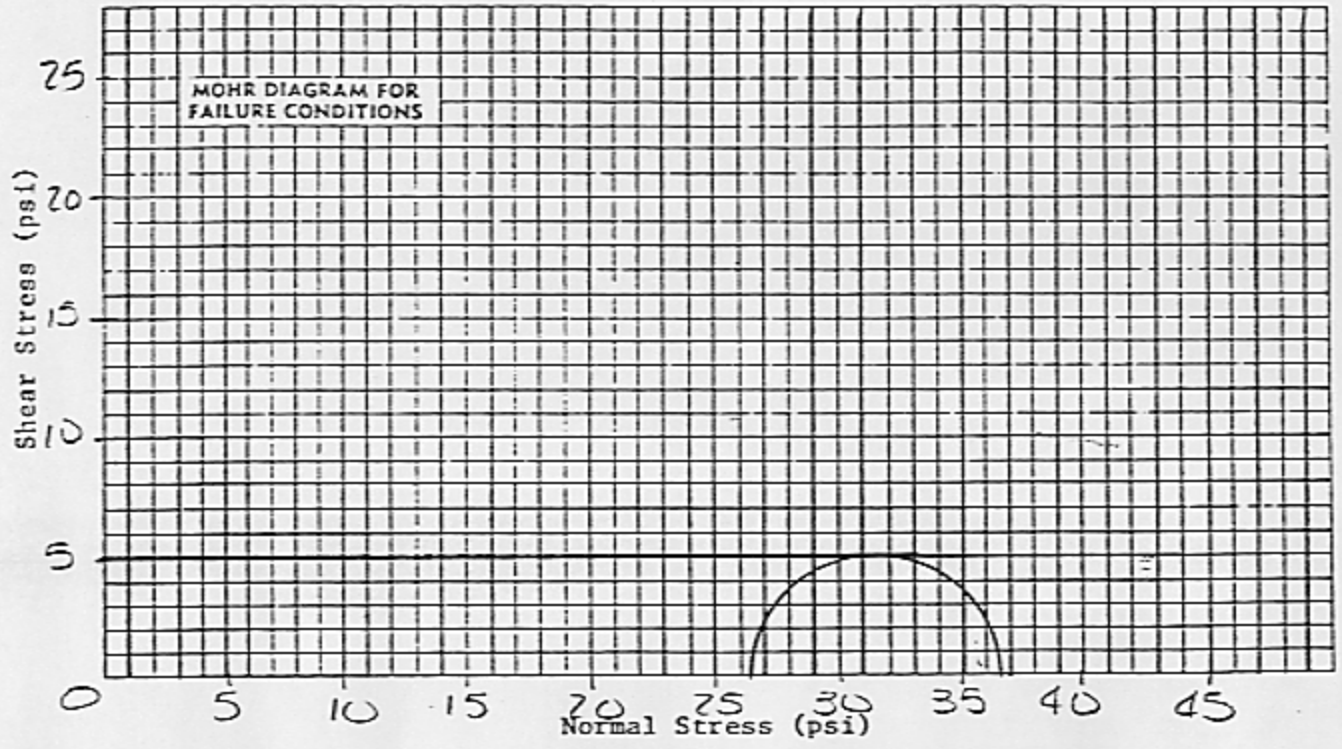
RATE OF SHEAR: 0.05 in/min

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: VA 1621





DESCRIPTION AND CLASSIFICATION OF SOIL SPECIMEN TESTED

CLAY, TRACE FINE SAND - GRAY (CH)

STRATUM: B

Key	Boring No.	Sample Depth, ft.	Lateral Pressure	Moist. Cont., % Initial	Moist. Cont., % Final	Density, pcf Dry	Density, pcf Wet
⊙	DH-3	84-86	26.4	82.2		52	95

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SOIL MECHANICS LABORATORY

TRIAXIAL COMPRESSION TEST

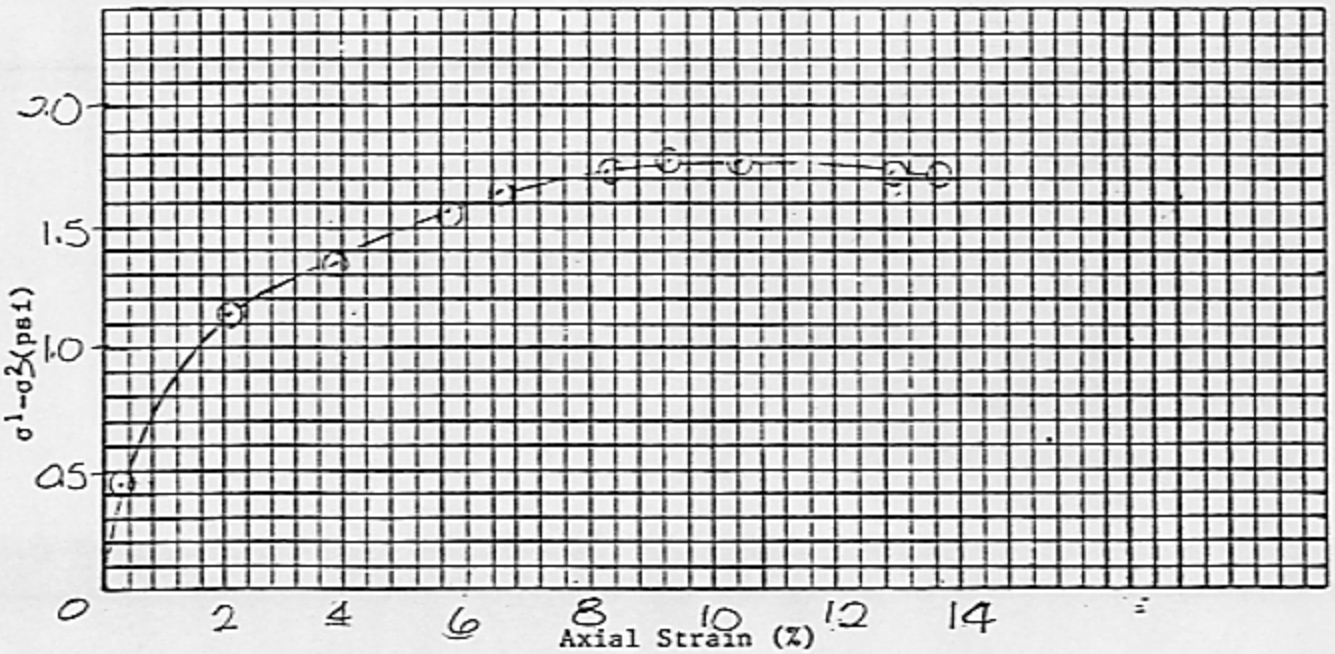
TYPE OF TEST: UNCONSOLIDATED UNDRAINED

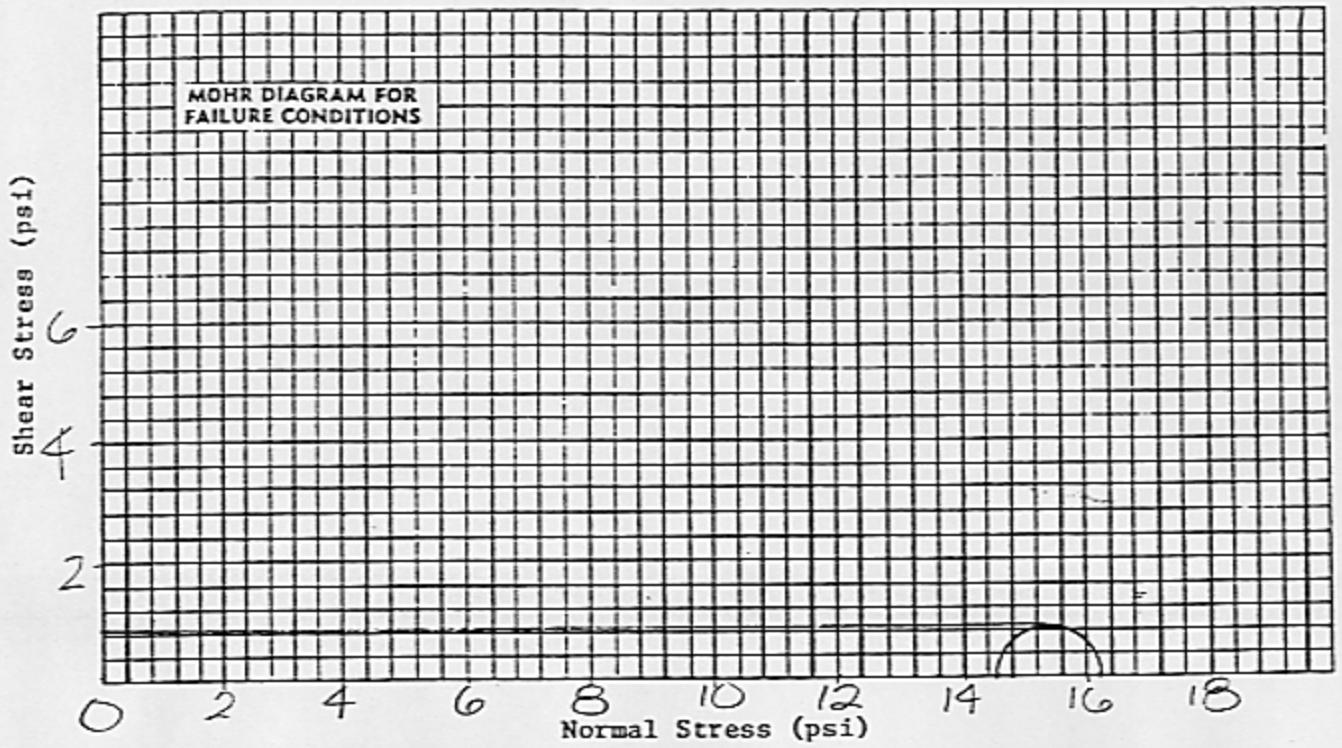
RATE OF SHEAR: 0.05 in/min.

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: V81-71





DESCRIPTION AND CLASSIFICATION OF SOIL SPECIMEN TESTED

CLAY, TRACE FINE SAND, GRAY (CH)

STRATUM: B

Key	Boring No.	Sample Depth, ft.	Lateral Pressure	Moist. Cont., % Initial	Moist. Cont., % Final	Density, pcf Dry	Density, pcf Wet
⊙	DH-5	44-46	14.5psi	67.8		58	98

SCHNABEL ENGINEERING ASSOCIATES
SOIL MECHANICS LABORATORY

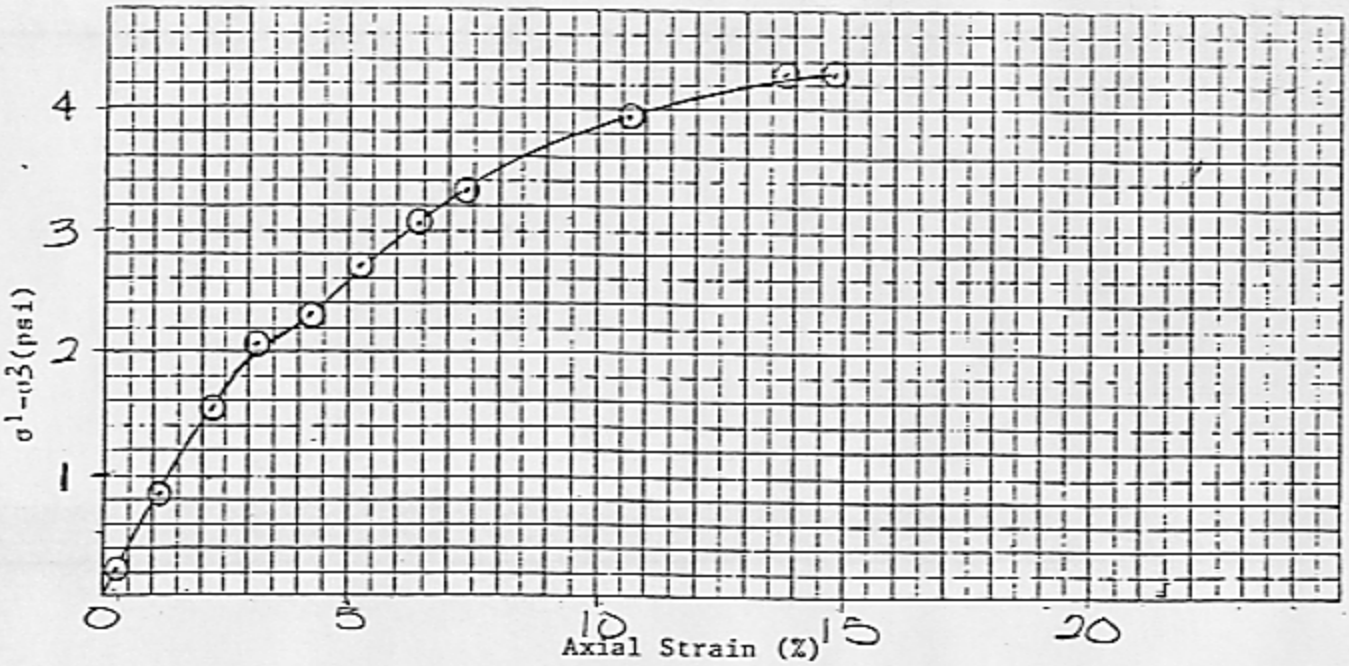
TRIAXIAL COMPRESSION TEST

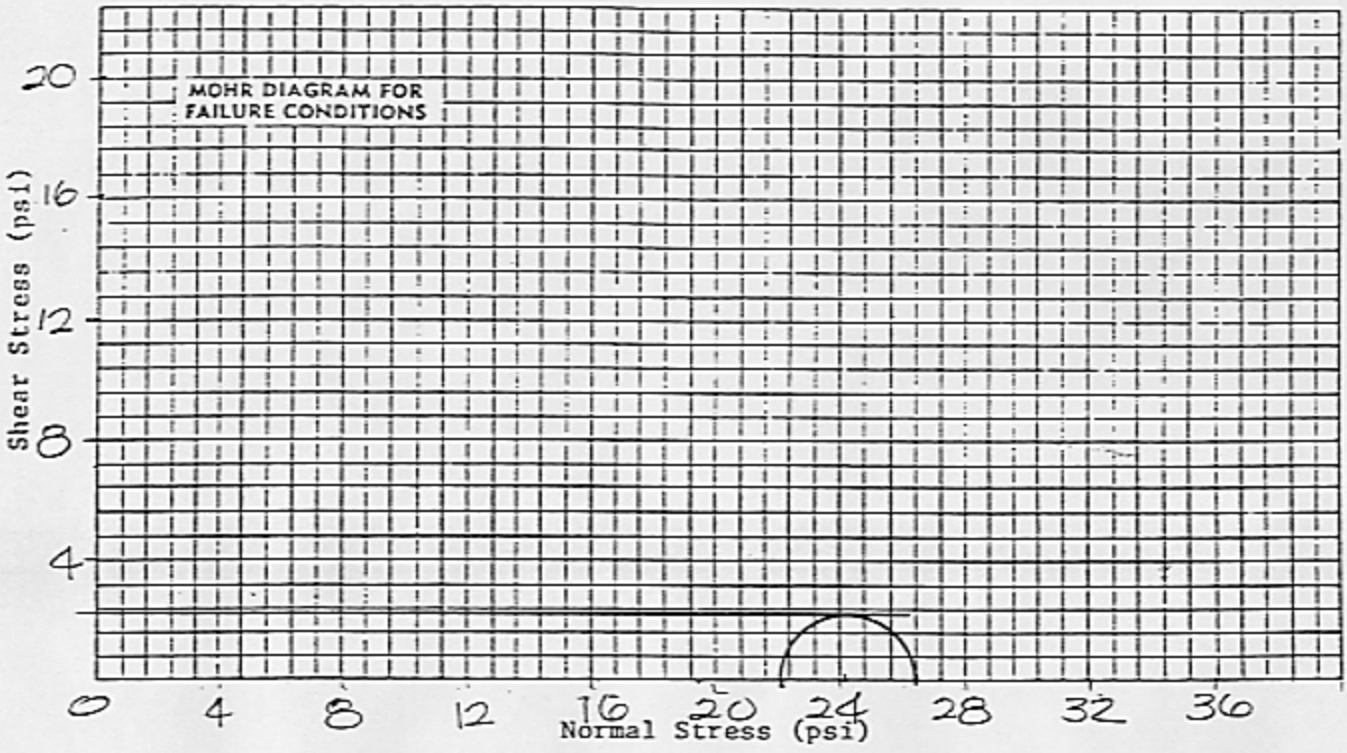
TYPE OF TEST: UNCONSOLIDATED UNDRAINED

RATE OF SHEAR: 0.05 in/min

PROJECT: CRANEY ISLAND
NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: 81621





DESCRIPTION AND CLASSIFICATION OF SOIL SPECIMEN TESTED

CLAY, TRACE FINE SAND, GRAY (CH)

STRATUM: B

Key	Boring No.	Sample Depth, ft.	Lateral Pressure	Moist. Cont., % Initial	Moist. Cont., % Final	Density, pcf Dry	Density, pcf Wet
0	DH-5	69-71	22.0	83.1	-	51	93

SCHNABEL ENGINEERING ASSOCIATES
SOIL MECHANICS LABORATORY

TRIAXIAL COMPRESSION TEST

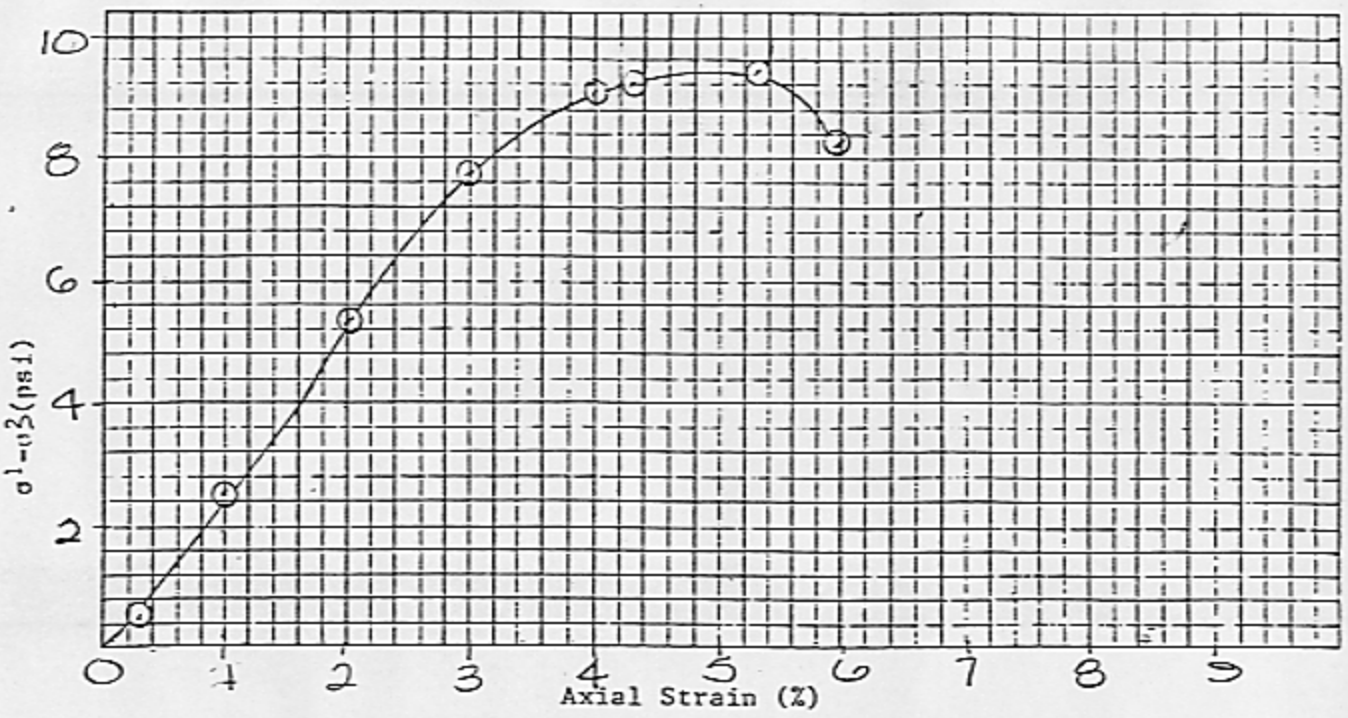
TYPE OF TEST: UNCONSOLIDATED UNDRAINED

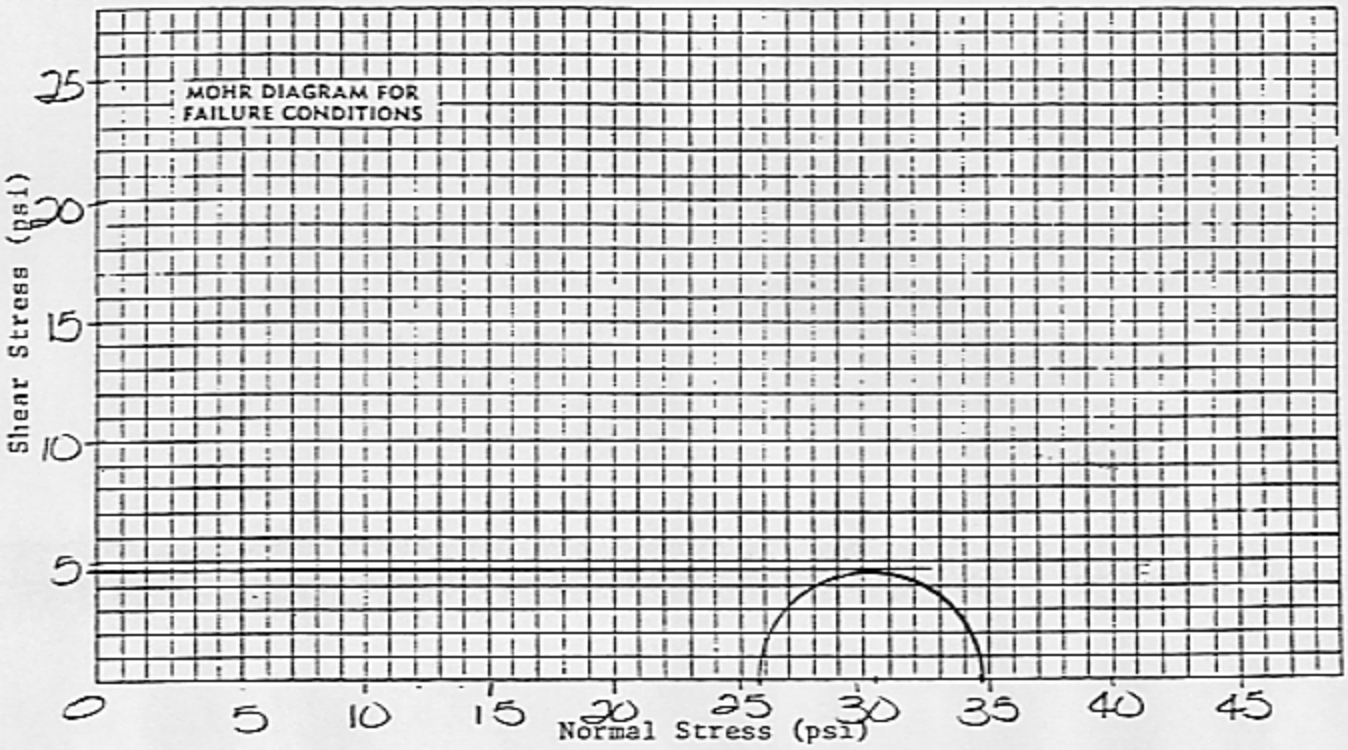
RATE OF SHEAR: 0.05 in/min

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: V8162





DESCRIPTION AND CLASSIFICATION OF SOIL SPECIMEN TESTED

CLAY, TRACE FINE SAND, GRAY (CH)

STRATUM: B

Key	Boring No.	Sample Depth, ft.	Lateral Pressure	Moist. Cont., % Initial	Moist. Cont., % Final	Density, pcf Dry	Density, pcf Wet
0	DH-5	84-86	25.7	42.7	-	66	94

SCHNABEL ENGINEERING ASSOCIATES
SOIL MECHANICS LABORATORY

TRIAXIAL COMPRESSION TEST

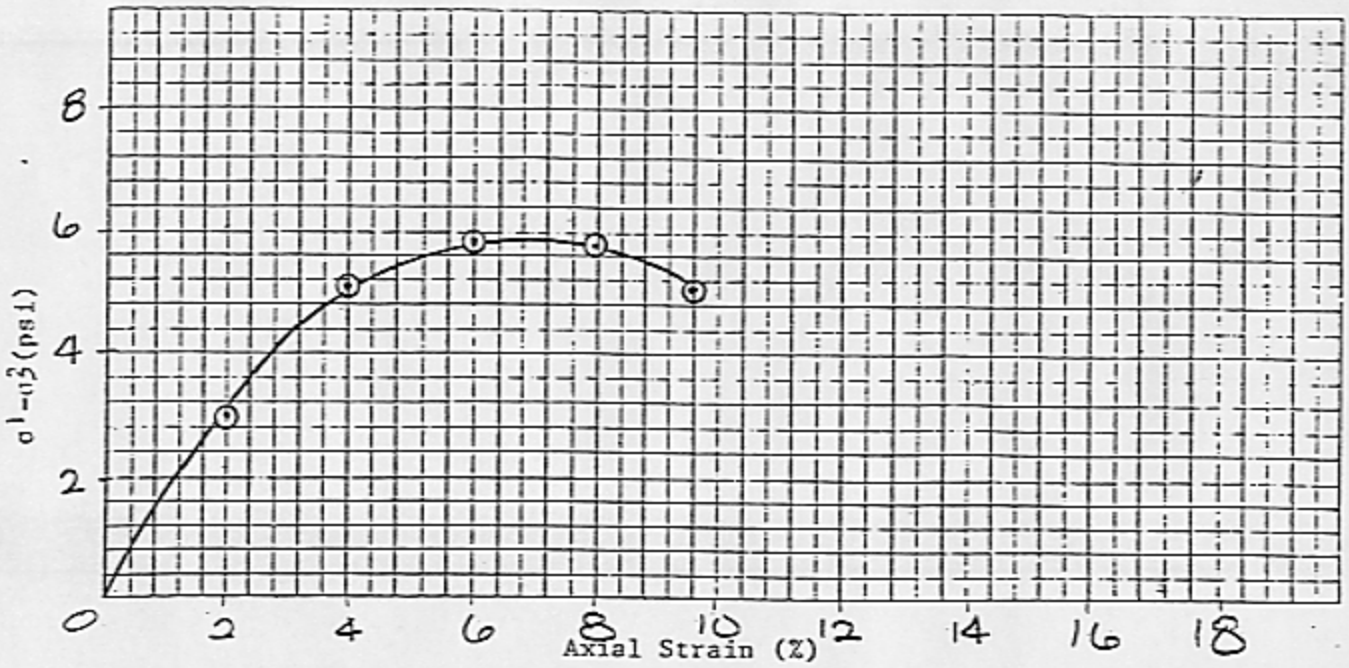
TYPE OF TEST: UNCONSOLIDATED UNDRAINED

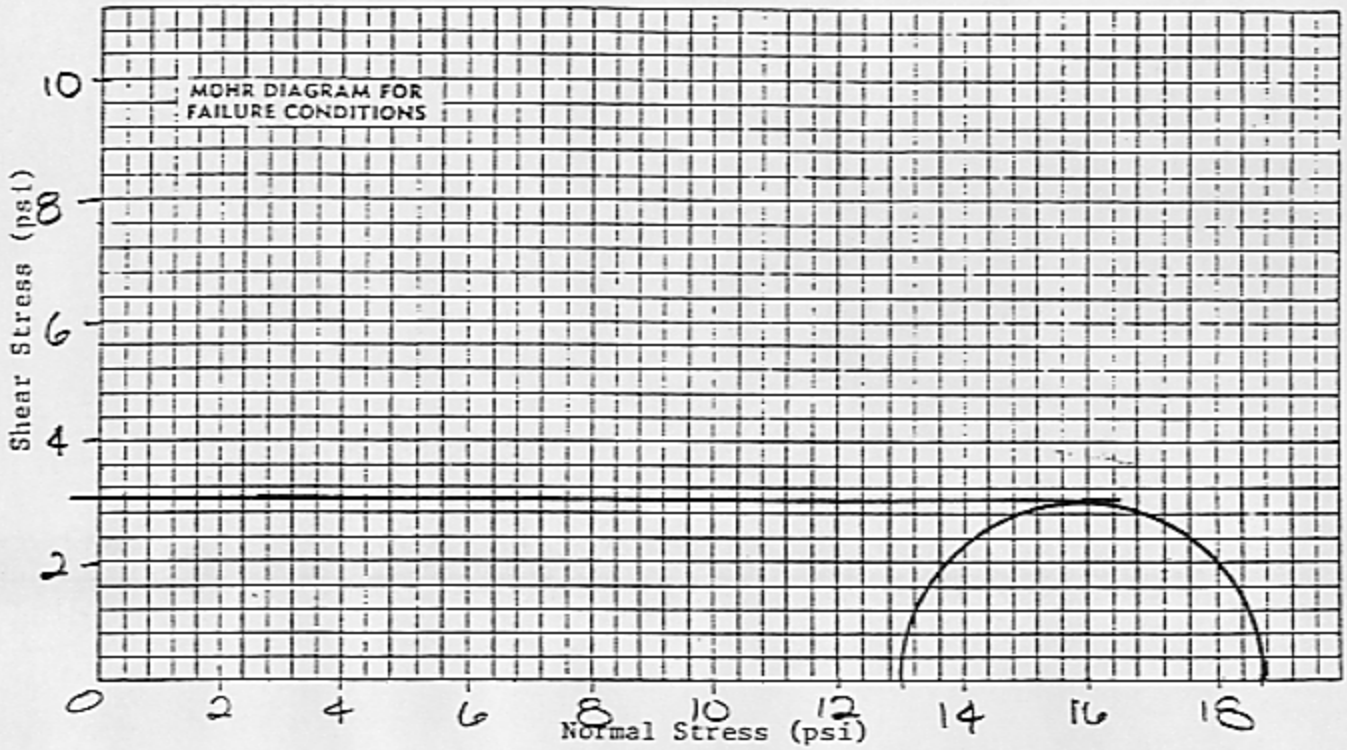
RATE OF SHEAR: 0.05 in/min.

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: V81621





DESCRIPTION AND CLASSIFICATION OF SOIL SPECIMEN TESTED

CLAY, TRACE FINE SAND, GRAY (CH)

STRATUM: B

Key	Boring No.	Sample Depth, ft.	Lateral Pressure	Moist. Cont., % Initial	Moist. Cont., % Final	Density, pcf Dry	Density, pcf Wet
⊙	DH-6	34-36	13	64.6		63	103

SCHNABEL ENGINEERING ASSOCIATES
SOIL MECHANICS LABORATORY

TRIAXIAL COMPRESSION TEST

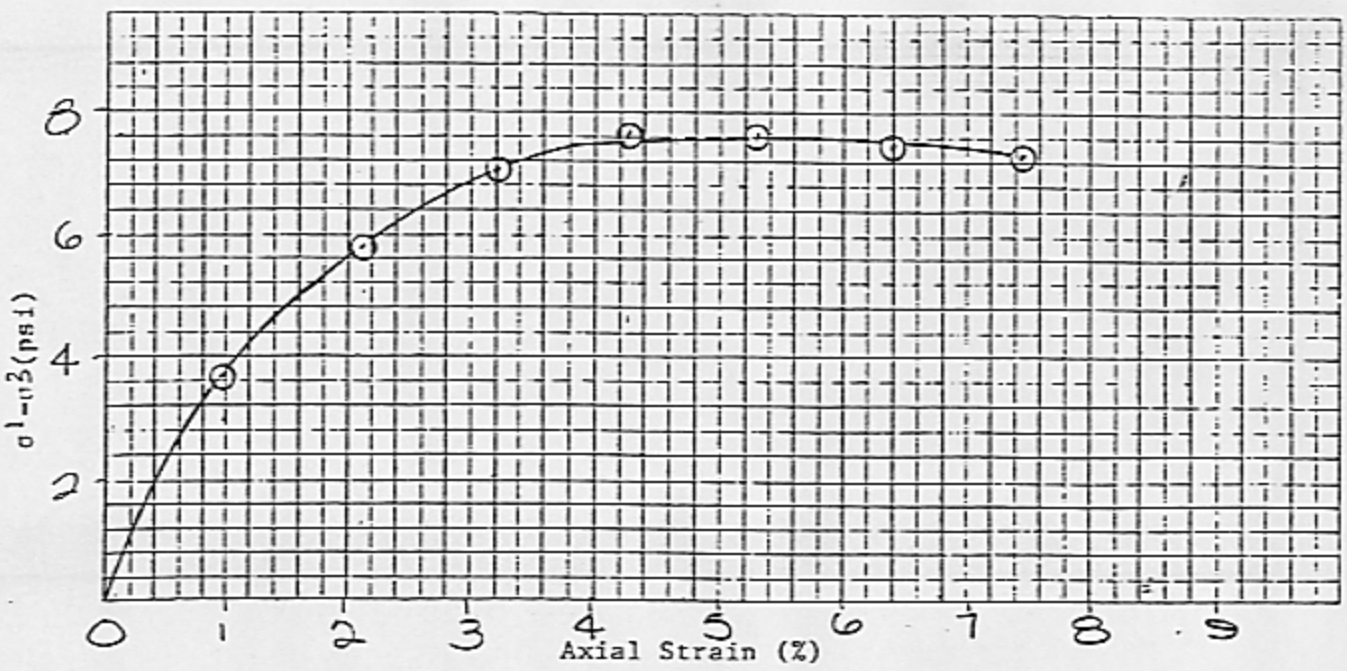
TYPE OF TEST: UNCONSOLIDATED UNDRAINED

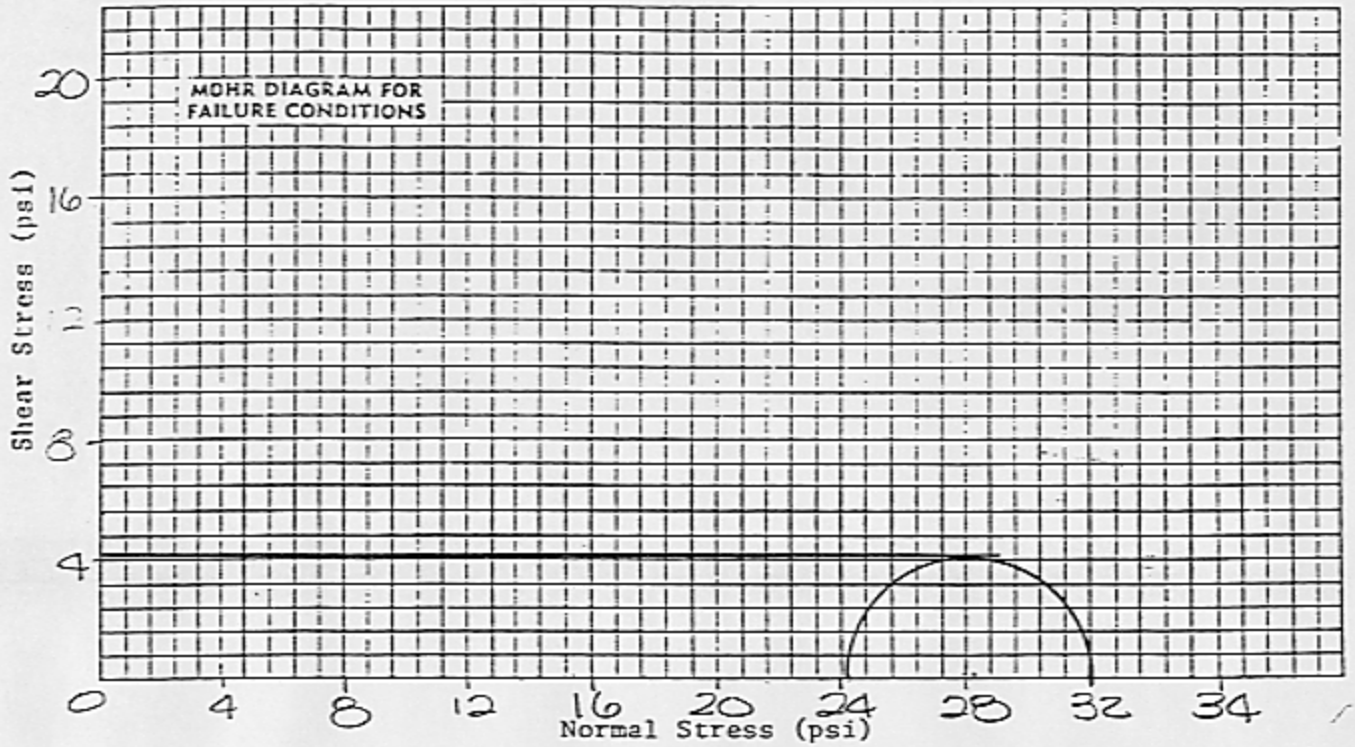
RATE OF SHEAR:

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: V81621





DESCRIPTION AND CLASSIFICATION OF SOIL SPECIMEN TESTED

CLAY, TRACE FINE SAND, GRAY (CH)

STRATUM: B

Key	Boring No.	Sample Depth, ft.	Lateral Pressure	Moist. Cont., % Initial	Moist. Cont., % Final	Density, pcf Dry	Density, pcf Wet
⊙	DH-6	79-81	24.3	81.0		52	94

SCHNABEL ENGINEERING ASSOCIATES
SOIL MECHANICS LABORATORY

TRIAXIAL COMPRESSION TEST

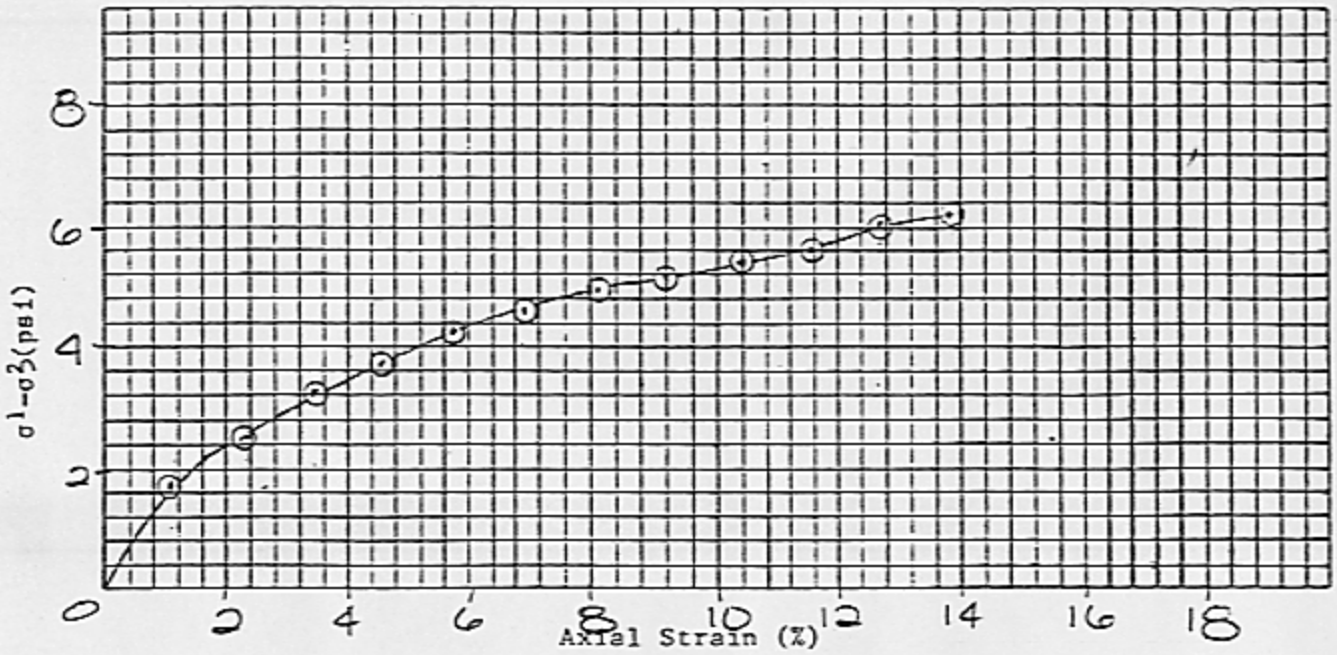
TYPE OF TEST: UNCONSOLIDATED UNDRAINED

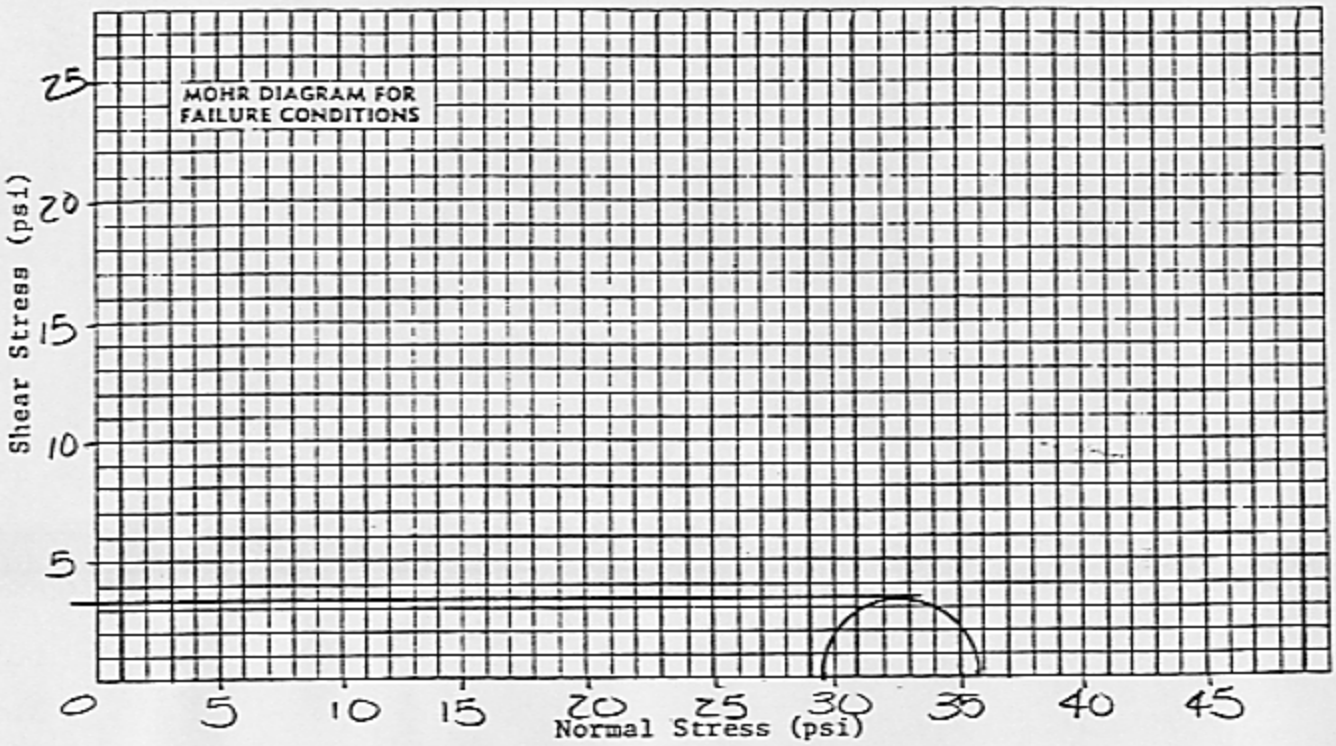
RATE OF SHEAR: 0.05 in/min

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: V8162I





DESCRIPTION AND CLASSIFICATION OF SOIL SPECIMEN TESTED

CLAY, TRACE FINE SAND, GRAY, (CH)

STRATUM: B

Key	Boring No.	Sample Depth, ft.	Lateral Pressure	Moist. Cont., % Initial	Moist. Cont., % Final	Density, pcf Dry	Density, pcf Wet
⊙	DH-6	99-101	2.5 psi	69.2		58	99

SCHNABEL ENGINEERING ASSOCIATES
SOIL MECHANICS LABORATORY

TRIAXIAL COMPRESSION TEST

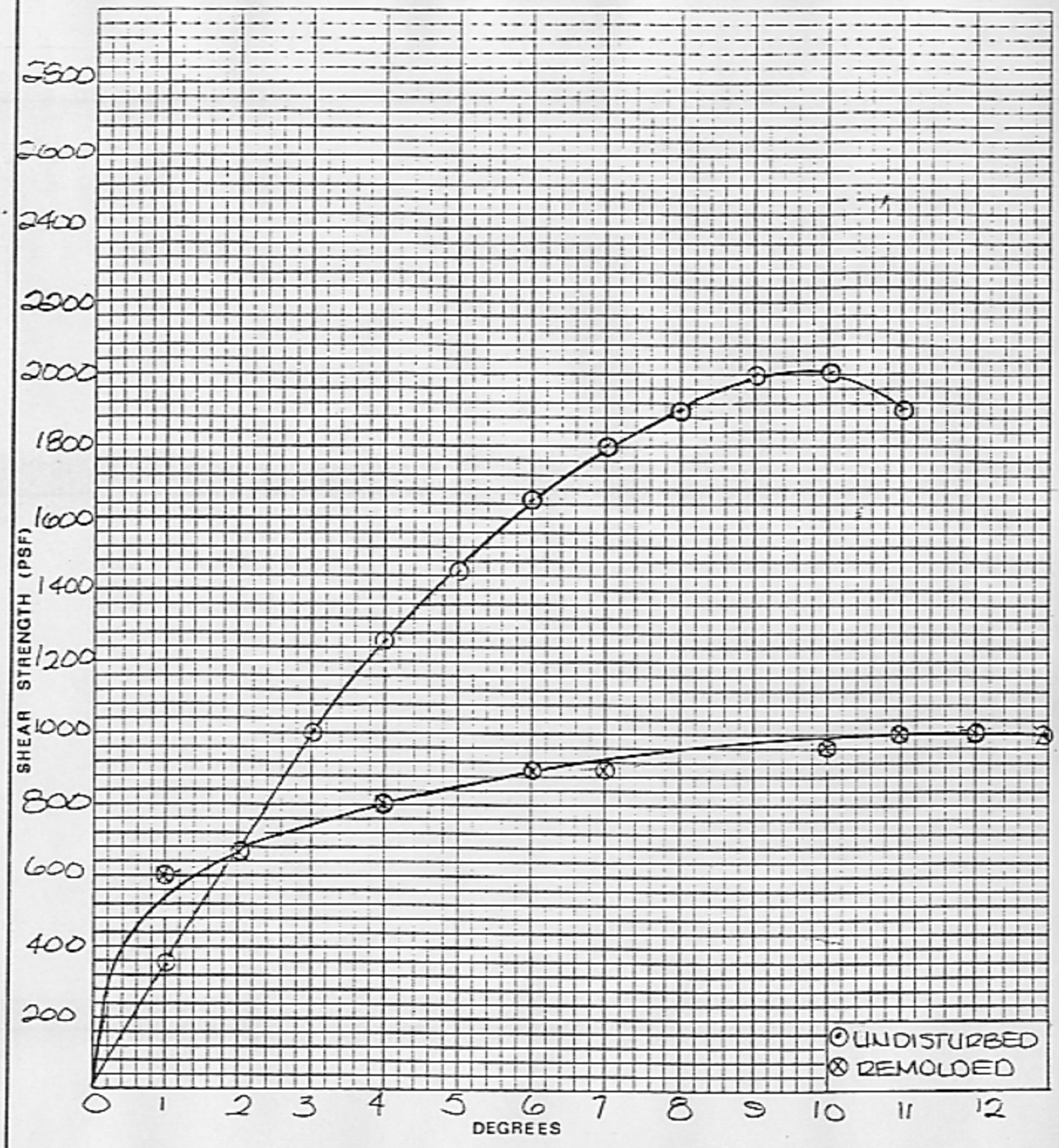
TYPE OF TEST: UNCONSOLIDATED UNDRAINED

RATE OF SHEAR: 0.05 in/min

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: V81621

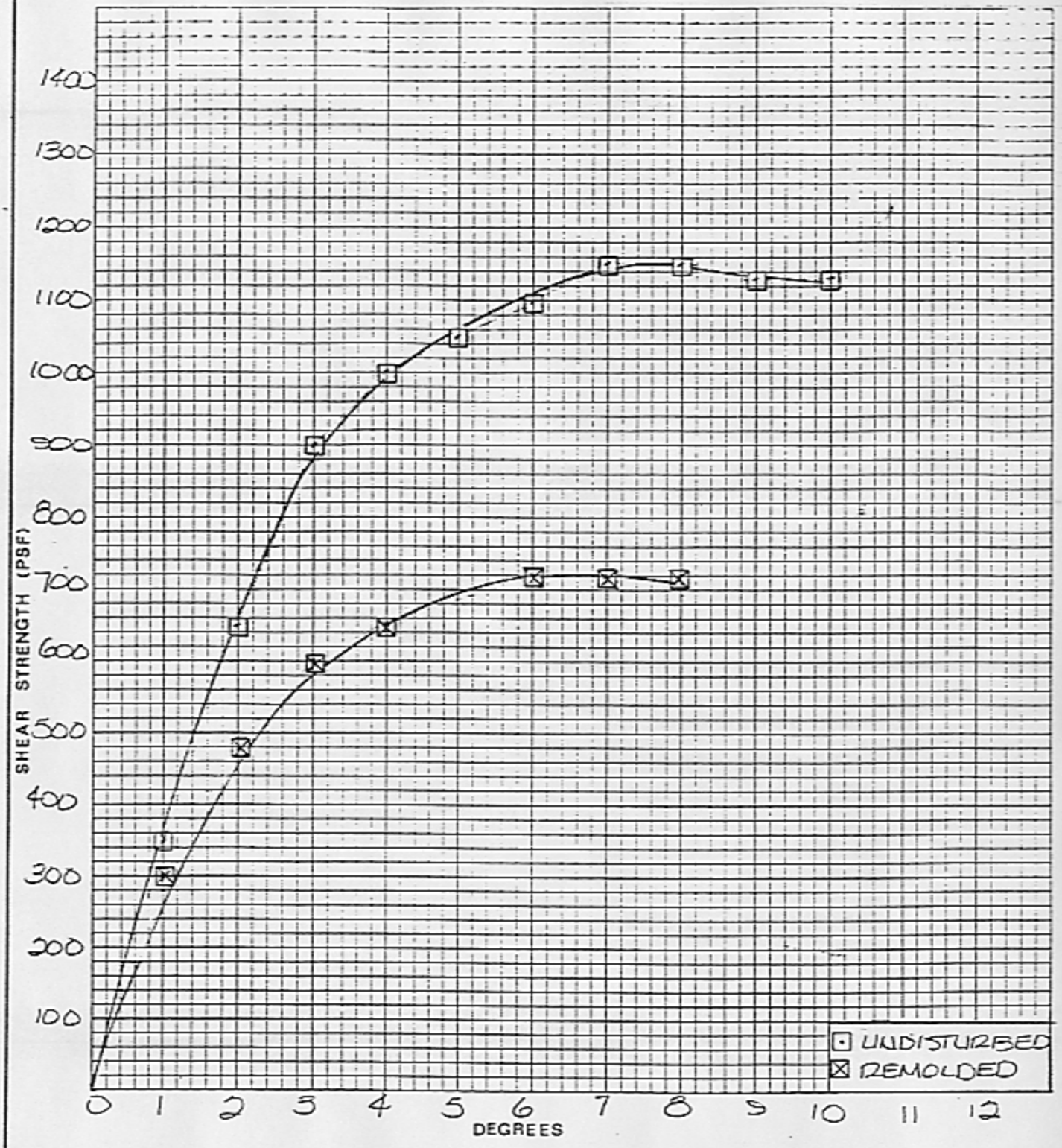


DESCRIPTION OF SOIL SAMPLE TESTED	SCHNABEL ENGINEERING ASSOCIATES
CLAY, TRACE FINE SAND, GRAY (CH)	FIELD VANE SHEAR TEST

RATE: 1/2° PER MINUTE

KEY	DEPTH	BORING	SHEAR STRENGTH UNDISTURBED	SHEAR STRENGTH REMOLDED
⊙⊗	76-78	DH-1	2000	1000

PROJECT: CRANEY ISLAND
NORFOLK, VIRGINIA
DATE: 1-22-82 CONTR. NO.: V81621



DESCRIPTION OF SOIL SAMPLE TESTED

CLAY, TRACE FINE SAND, GRAY (CH)

SCHNABEL ENGINEERING ASSOCIATES

FIELD VANE SHEAR TEST

RATE: 1 1/2° PER MINUTE

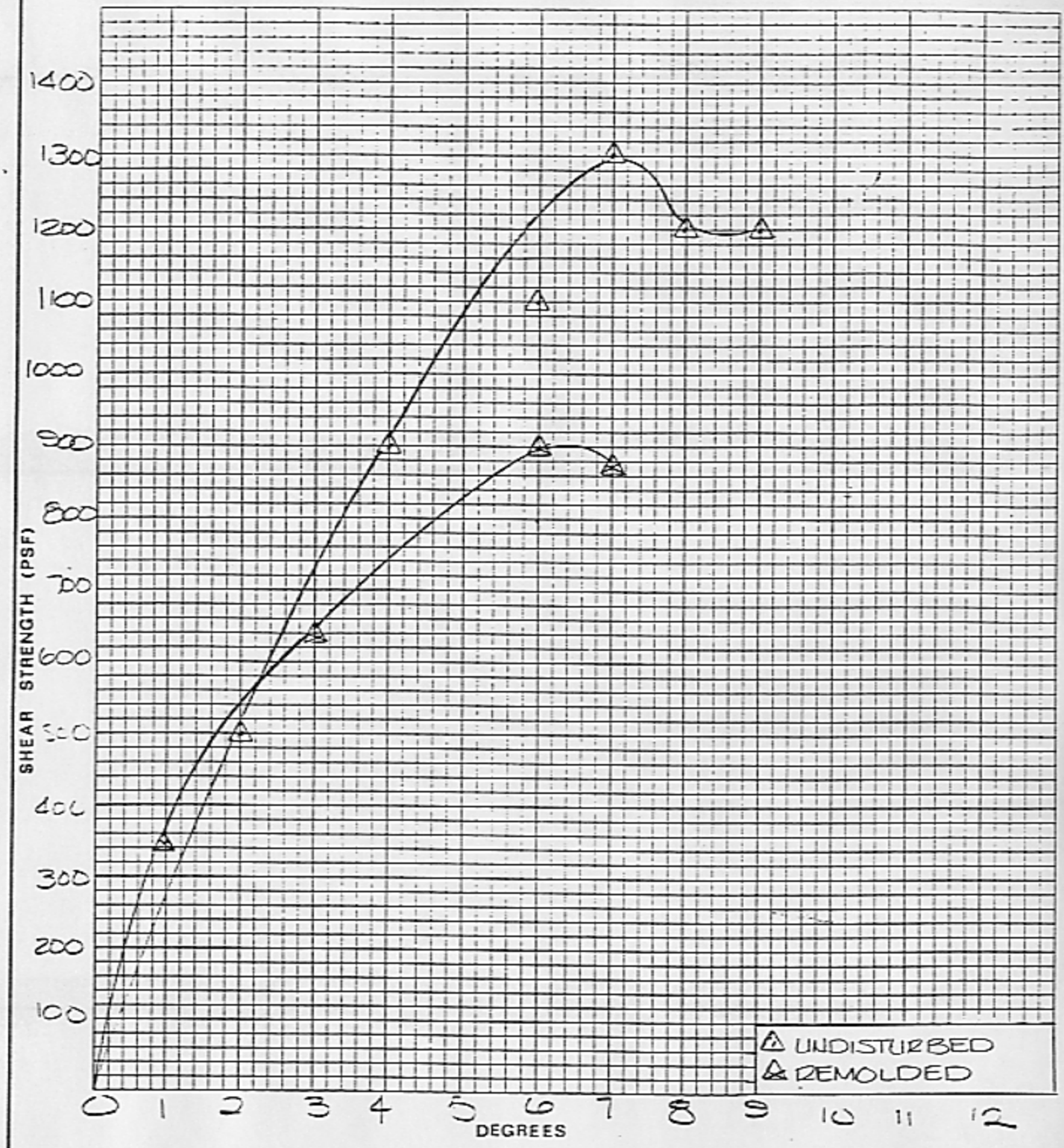
KEY	DEPTH	BORING	SHEAR STRENGTH UNDISTURBED	SHEAR STRENGTH REMOLDED
⊡ ⊠	84-86	DH-1	1250	720

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82

CONTR. NO.: V81671



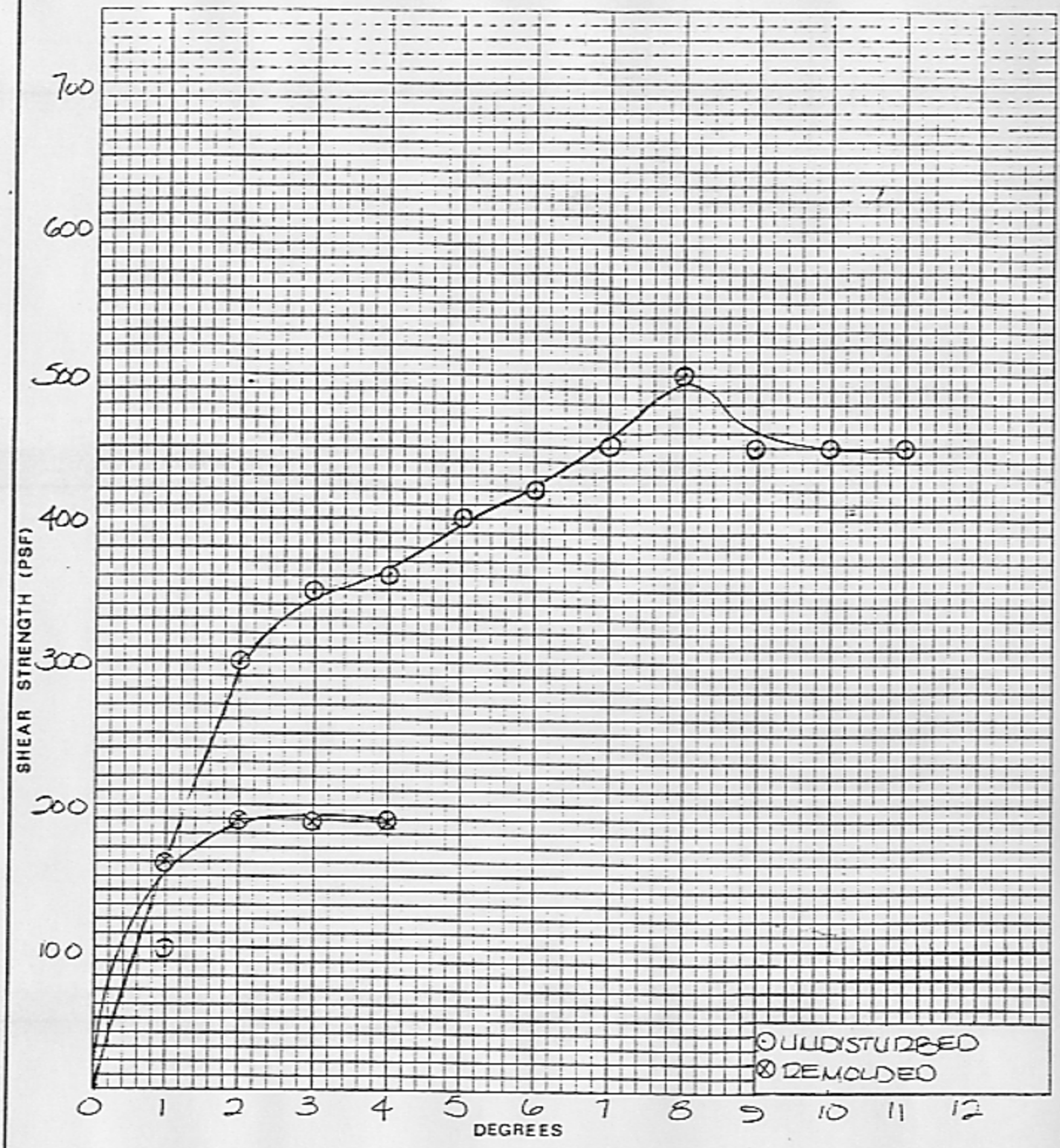
DESCRIPTION OF SOIL SAMPLE TESTED	SCHNABEL ENGINEERING ASSOCIATES
CLAY, TRACE FINE SAND, GRAY (CH)	FIELD VANE SHEAR TEST

RATE: 1 1/2° PER MINUTE

KEY	DEPTH	BORING	SHEAR STRENGTH UNDISTURBED	SHEAR STRENGTH REMOLDED
△&	94-96	DH-1	1300	900

PROJECT: CRANEY ISLAND
NORFOLK, VIRGINIA

DATE: 1-22-82 | CONTR. NO.: V8162



DESCRIPTION OF SOIL SAMPLE TESTED				
CLAY, TRACE FINE SAND GRAY (CH)				
RATE: 1 1/2° PER MINUTE			SHEAR STRENGTH (psf)	
KEY	DEPTH	BORING	UNDISTURBED	REMOLDED
⊙⊗	34-36'	DH-4	450	190

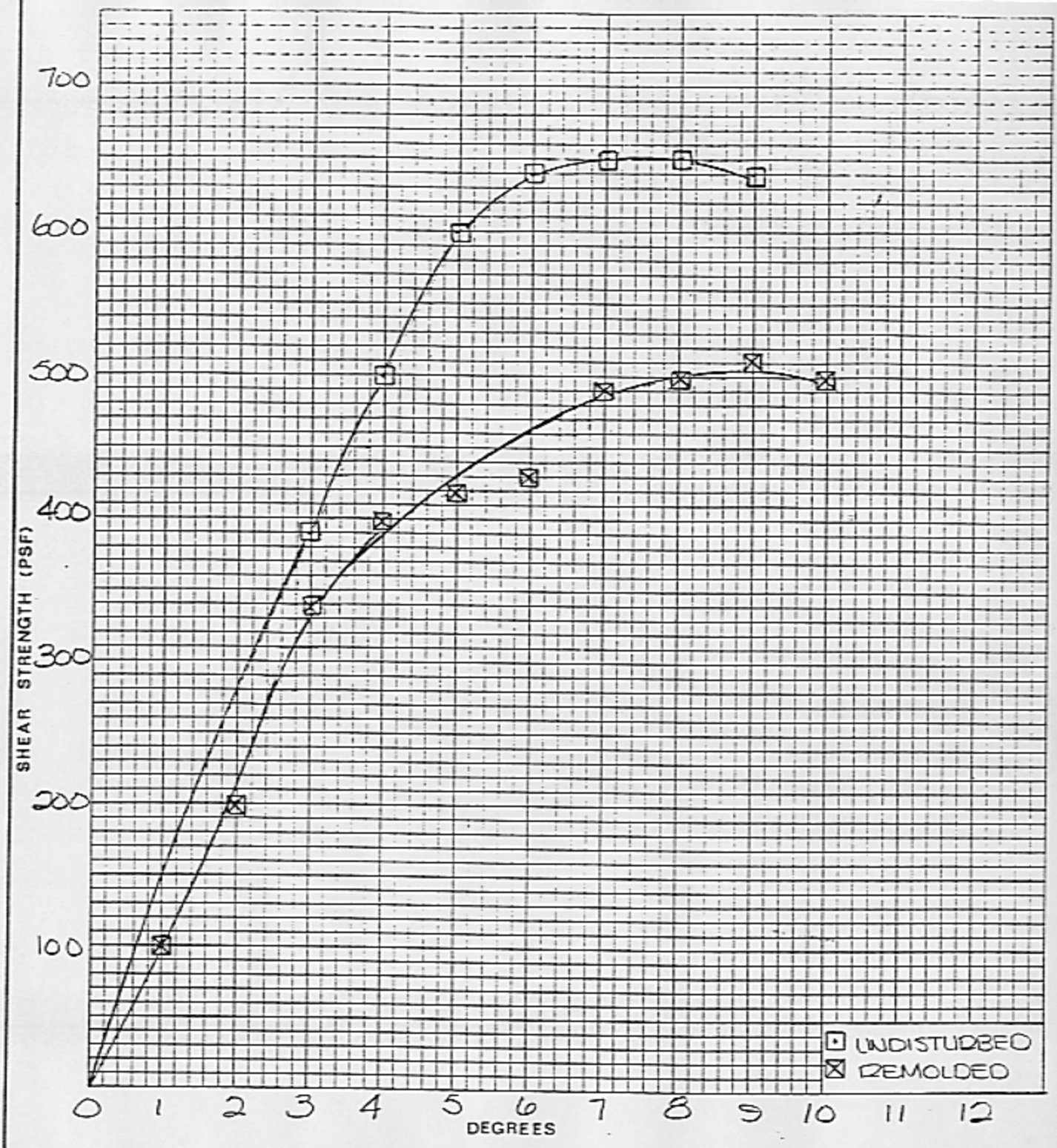
SCHNABEL ENGINEERING ASSOCIATES

FIELD VANE SHEAR TEST

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82 | CONTR. NO.: V81621



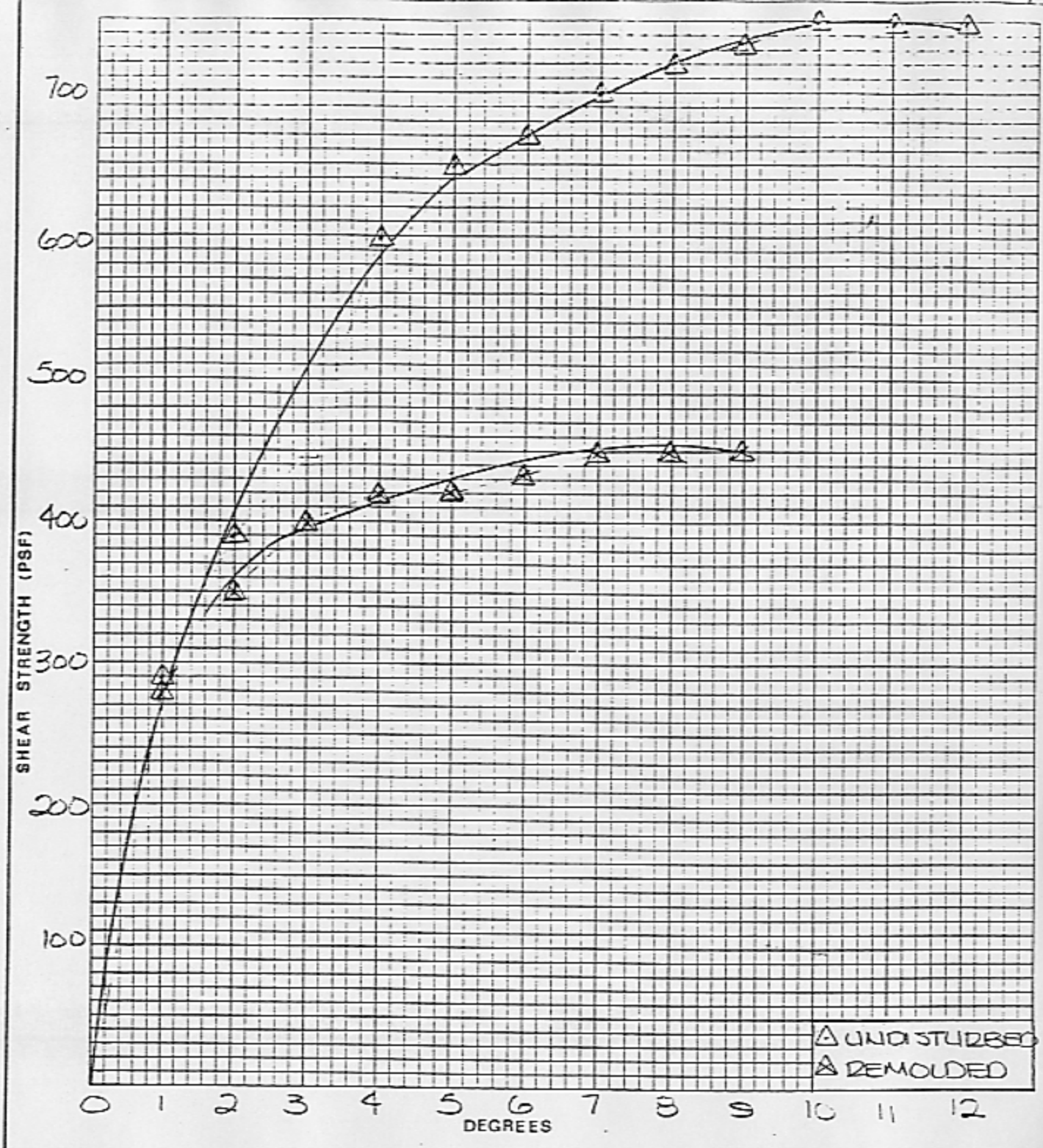
DESCRIPTION OF SOIL SAMPLE TESTED	SCHNABEL ENGINEERING ASSOCIATES
CLAY, TRACE FINE SAND, GRAY (CH)	FIELD VANE SHEAR TEST

RATE: 1 1/2° PER MINUTE

KEY	DEPTH	BORING	SHEAR STRENGTH (psf) UNDISTURBED	REMOLDED
⊡⊠	59-61	DH-4	650	510
	-ENS			

PROJECT: CRANEY ISLAND
NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: Y8162



DESCRIPTION OF SOIL SAMPLE TESTED

CLAY, TRACE FINE SAND, GRAY, (CH)

SCHNABEL ENGINEERING ASSOCIATES

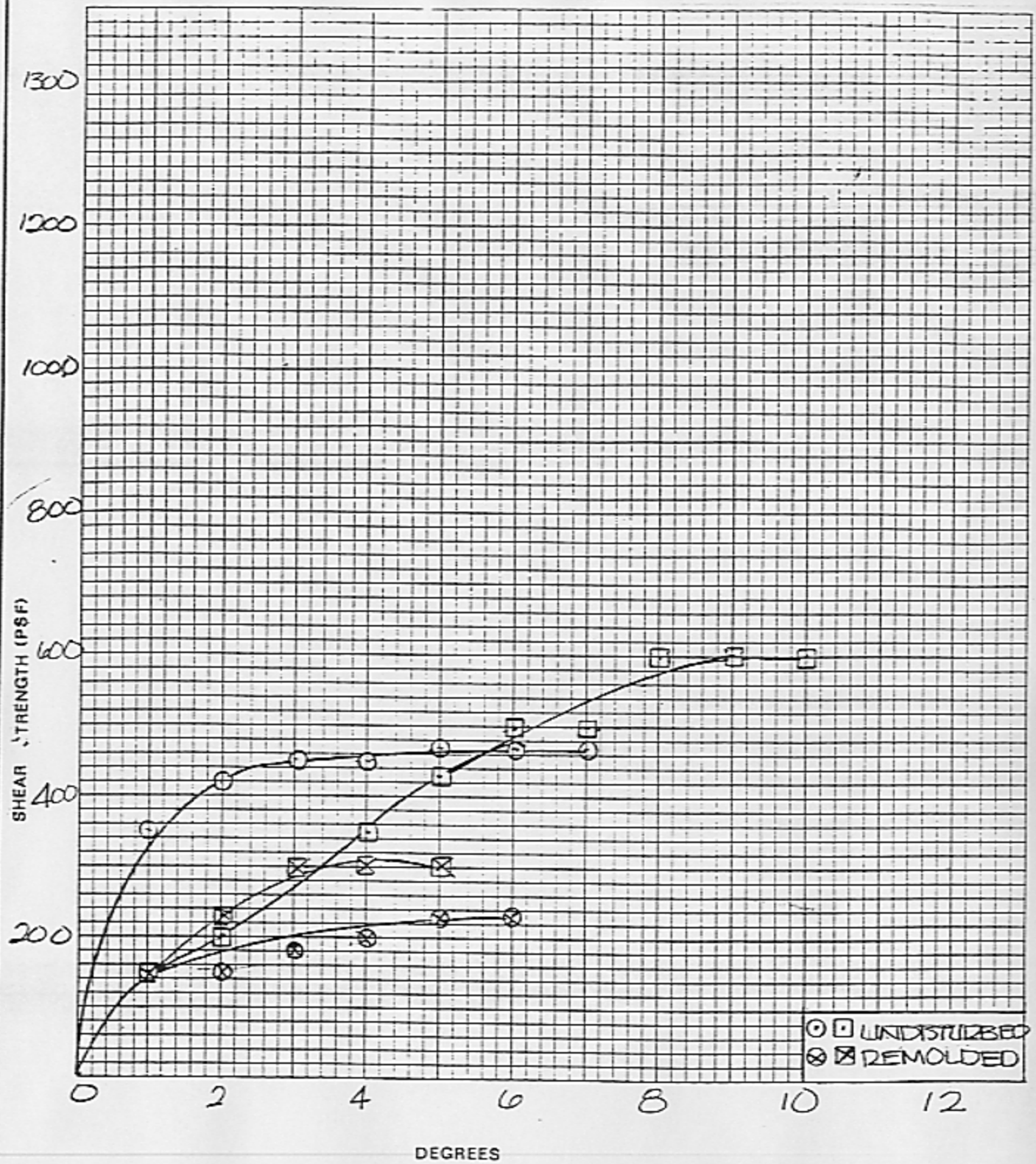
FIELD VANE SHEAR TEST

RATE: 1½° PER MINUTE

KEY	DEPTH	BORING	SHEAR STRENGTH (psf) UNDISTURBED	REMOLDED
△△	84-86	DH-4	750	450

PROJECT: CRANEY ISLAND
NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: Y81621



DESCRIPTION OF SOIL SAMPLE TESTED				
CLAY, TRACE FINE SAND, GRAY (CH)				
RATE: 1°/0 PER MINUTE			SHEAR STRENGTH	
KEY	BORING	DEPTH	UNDISTURBED	REMOLDED
⊙⊗	DH-7	44-46'	475 psf	225 psf
		~~38.6~~		
⊡⊠	DH-7	69-71	600 psf	300 psf

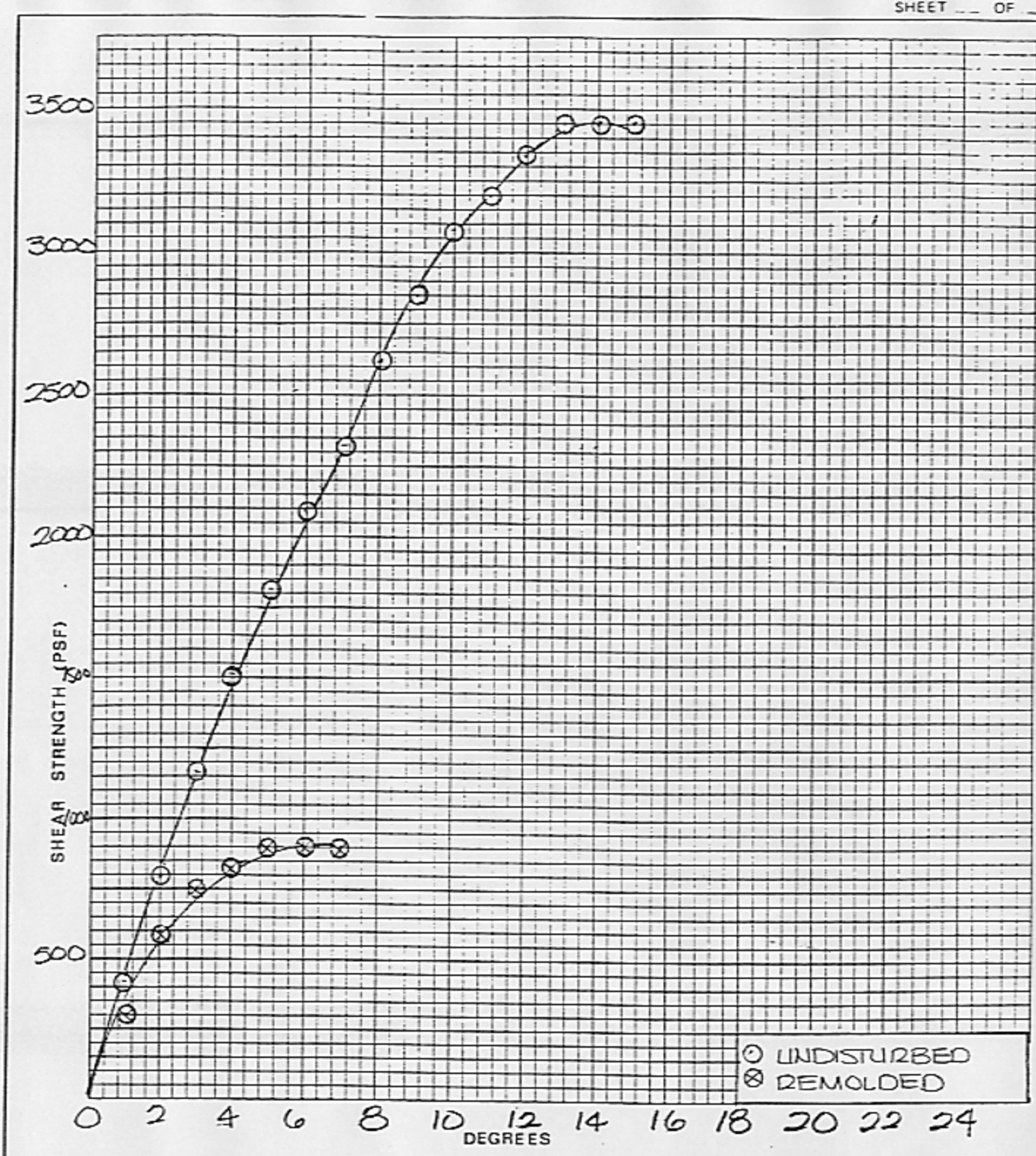
~~69.6~~

SCHNABEL ENGINEERING ASSOCIATES

FIELD VANE SHEAR TEST

PROJECT: CRANEY ISLAND, NORFOLK, VIRGINIA

DATE: 1-22-82 CONTR. NO.: V81621



DESCRIPTION OF SOIL SAMPLE TESTED

FINE SANDY CLAY, DARK GRAY (CL)

RATE: 1° PER MINUTE

KEY	BORING	DEPTH	SHEAR STRENGTH UNDISTURBED	SHEAR STRENGTH REMOLDED
⊙ ⊗	DH-7	99-101	3450psf	900psf
		-93-4		

SCHNABEL ENGINEERING ASSOCIATES

FIELD VANE SHEAR TEST

PROJECT: CRANEY ISLAND

NORFOLK, VIRGINIA

DATE: 1-22-82 | CONTR. NO.: V81621

SUBSURFACE EXPLORATION DATA

General Notes for Test Boring Logs

Identification of Soil Samples

Test Boring Logs, DH-1 through DH-7

General Site Location Plan, Sheet 1

Estimated Subsurface Profile, Sheet 2

Test Borings

All borings were drilled by hollow stem auger equipment. The Standard Penetration Test (SPT) was performed at the depths indicated on the Test Boring Logs. The augers were advanced to the desired depth with plug inserted. The SPT was performed following removal of the plug. Water level data is indicated on the logs.

Boring Location and Elevation Survey

Test borings were located in the field by Corps of Engineers personnel. Test boring elevations were estimated based on a topographic survey of the site dated April, 1980, provided to us by the Corps of Engineers.

GENERAL NOTES FOR TEST BORING LOGS

1. NUMBERS IN "SAMPLE SPOON" COLUMN INDICATE BLOWS REQUIRED TO DRIVE A 2 INCH O.D., 1-3/8 INCH I.D. SAMPLING SPOON 6 INCHES USING A 140 POUND HAMMER FALLING 30 INCHES ACCORDING TO ASTM D-1586.

2. VISUAL CLASSIFICATION OF SOIL IS IN ACCORDANCE WITH TERMINOLOGY SET FORTH IN "IDENTIFICATION OF SOIL." THE UNIFIED SOIL CLASSIFICATION SYMBOLS SHOWN IN PARENTHESES ARE BASED ON VISUAL INSPECTION.

3. ESTIMATED GROUNDWATER LEVELS INDICATED BY ▼; THESE LEVELS ARE ONLY ESTIMATES FROM AVAILABLE DATA AND MAY VARY WITH PRECIPITATION, POROSITY OF THE SOIL, SITE TOPOGRAPHY, ETC.

4. REFUSAL AT THE SURFACE OF ROCK, BOULDER, OR OBSTRUCTION IS DEFINED AS A PENETRATION RESISTANCE OF 100 BLOWS FOR 2 INCHES PENETRATION OR LESS.

5. THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND AT THE PARTICULAR TIME WHEN DRILLED. SOIL CONDITIONS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE BORING LOCATIONS. ALSO, THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE SUBSURFACE SOIL AND GROUNDWATER CONDITIONS AT THESE BORING LOCATIONS.

6. THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL AND ROCK TYPES AS DETERMINED FROM THE DRILLING AND SAMPLING OPERATION. SOME VARIATION MAY ALSO BE EXPECTED VERTICALLY BETWEEN SAMPLES TAKEN. THE SOIL PROFILE, WATER LEVEL OBSERVATIONS AND PENETRATION RESISTANCES PRESENTED ON THESE BORING LOGS HAVE BEEN MADE WITH REASONABLE CARE AND ACCURACY AND MUST BE CONSIDERED ONLY AN APPROXIMATE REPRESENTATION OF SUBSURFACE CONDITIONS TO BE ENCOUNTERED AT THE PARTICULAR LOCATION.

7. BORING LOG VERTICAL SCALE: 1/10 INCH = 1 FT.

8. TEST BORINGS DRILLED BY AYERS AND AYERS, INC., RICHMOND, VIRGINIA UNDER INSPECTION OF SCHNABEL ENGINEERING ASSOCIATES.

9. KEY TO SYMBOLS AND ABBREVIATIONS:

STANDARD PENETRATION TEST

2" or 3" UNDISTURBED TUBE SAMPLE (RECOVERY SHOWN IN REMARKS COLUMN)

PRESSUREMETER TEST

VANE SHEAR TEST

STATIC CONE PENETRATION TEST

NX OR 2 INCH O.D. ROCK CORE RUN (RECOVERY SHOWN IN REMARKS COLUMN)

*, NO SAMPLE RECOVERY

do, DITTO

RQD, ROCK QUALITY DESIGNATION

w, NATURAL MOISTURE CONTENT

SCHNABEL ENGINEERING ASSOCIATES

Consulting Geotechnical Engineers

IDENTIFICATION OF SOIL

I. DEFINITION OF SOIL COMPONENTS

Major Material Component	Material Fraction	Sieve Size	Plasticity
GRAVEL, GM, GC, GP, GW	Coarse Fine	3/4 to 3" No. 4 to 3/4	– –
SAND, SM, SC, SP, SW	Coarse Medium Fine	No. 10 to No. 4 No. 40 to No. 10 No. 200 to No. 40	– – –
SILT, ML	–	Passing No. 200	Non-plastic
CLAYEY SILT, ML, MH, CL-ML	–	Passing No. 200	Slight to High
SILTY CLAY, CL	–	Passing No. 200	Medium to High
CLAY, CH	–	Passing No. 200	Very High
ORGANIC SILT, OH, OL	–	Passing No. 200	Slight to High
PEAT, Pt	Partially decomposed fibrous organic matter with or without silt or sand filter		

II. DEFINITION OF COMPONENT PROPERTIES

Component	Proportions of Soil Components	Approximate Percentage by Weight
Major	Noun Form Gravel, Sand, Silt, Clay, etc.	50 or more
Minor	Adjective Form Gravelly, Sandy, Silty, Clayey Silty, Clayey, Silty Clayey	35 to 50
	Some Some Gravel, Some Silt, etc.	12 to 35
	Trace Trace Gravel, trace sand, etc.	1 to 12
	With with rock fragments, with organic matter, etc.	indicates presence only

III. GLOSSARY OF MISCELLANEOUS TERMS

SYMBOLS – Unified Soil Classification Symbols are shown in major material component column. Use A Line Chart for laboratory identification.

BOULDERS – Rounded pieces of rock larger than 3 inches

DISINTEGRATED ROCK – Residual soil with a standard penetration resistance of at least 60 blows or more per foot

ROCK FRAGMENTS – Angular pieces of rock, distinguished from transported gravel, which have separated from original vein or strata and are present in a soil matrix.

QUARTZ – A hard silica mineral often found in residual soils

IRONITE – Iron oxide deposited within a soil layer forming cemented deposits

CEMENTED SAND – Usually localized rock-like deposits within a soil stratum composed of sand grains cemented by calcium carbonate or other minerals

MICA – A soft silica mineral found in many rocks, and in residual or transported soils derived therefrom

FISSURED CLAYS – Cohesive soils exhibiting a joint structure

ORGANIC MATERIAL (Excluding Peat): **Top Soil** – Surface soils that support plant life and which contain considerable amounts of organic matter; **Decomposed Vegetation** – Partially decomposed organic matter which retains its original character; **Lignite** – Decomposed organic matter with low fixed carbon content frequently exhibiting distinct texture of wood

FILL – Man made deposit containing soil, rock and often foreign matter

PROBABLE FILL – Soils which contain no visually detectable foreign matter but which are suspect with respect to origin

LENSES – 0 to 1/2 inch layer of minor soil component

LAYERS – 1/2 to 12 inch layers of minor soil component

POCKET – Discontinuous pocket of minor soil component

COLOR SHADES – Light or dark to indicate substantial differences in color

MOISTURE CONDITIONS – Wet, moist, or dry to indicate visual appearance of specimen

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-1
PROJECT: WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 1 OF 2
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO.: V81621
BORING CONTRACTOR: AYERS AND AYERS, INC.	DRILL: CME-55	ELEVATION: 8.8±
WATER LEVEL DATA	DRIVE SAMPLER	CASING SIZE: 2½"
DATE / TIME / DEPTH / CAVED	TYPE: S.S.	DATE START: 1-5-82
ENCOUNTERED: 1-5 / 8:00 / 7.0' / -	DIA.: 2" OD	DATE FINISHED: 1-5-82
AFTER CASING PULLED: 1-5 / 3:34 / DRY / 1.5'	WT.: 140#	DRILLER: R. AYERS
___HR. READING: BACKFILL UPON COMPLETION	FALL: 30"	INSPECTOR: G. ADAMS

STRATUM	DEPTH FT.	EL. 8.8±	BLOWS ON SAMPLE SPOON, PER 6"	SYMBOL	IDENTIFICATION	REMARKS
			4+6+6	S	FINE TO COARSE SAND FILL, TRACE SILT, WITH SHELL FRAGMENTS, MOIST - TAN (SP)	
			5+6+19	S		
			10+16+17	S		
		0	4+4+4	S	do, WET	
	9.0		4+6+7	S	FINE SAND FILL, SOME SILT WITH SHELL FRAGMENTS, WET - GREEN (SM)	
			2+2+3	S		
		-10				
	19.0		9+12+27	S	FINE TO COARSE SAND FILL, TRACE SILT, WET GRAY (SP)	FILL
			4+5+5	S	do, FINE TO MEDIUM SAND, TRACE SILTY CLAY VARICOLORED	
		-20				
A			6+7+8	S	do, FINE TO COARSE SAND, TRACE SILT, TAN	
			5+6+7	S		
		-30				
			10+6+4	S		
	44.0		4+2+1	S	FINE SILTY SAND FILL, WET - GRAY (SM)	
		-40				
			5+6+7	S	do, TRACE SILT	
	54.0		7+12+14	S	FINE TO COARSE SAND FILL, TRACE SILT, WITH SHELL FRAGMENTS, WET - GRAY (SP)	
		-50				
			4+3+13	S		
			6+6+12	S		

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-1
PROJECT: WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO 2 OF 2
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO : V81621
BORING CONTRACTOR: AYERS AND AYERS, INC.		ELEVATION & DATUM

	DEPTH FT.	ELEV.	BLOWS ON SAMPLE SPOON PER 6"	SYMBOL	IDENTIFICATION	REMARKS
					FINE TO COARSE SAND, TRACE SILT, WET - GRAY (SP)	
		-60				
	69.0					
A			14+12+16	S	FINE SAND, SOME CLAYEY SILT, WET - GRAY (SM)	FILL
	74.0					
			2+2+2	S	CLAY, TRACE FINE SAND, WET - DARK GRAY (CH)	Su = 2000 psf
				V		
		-70				
			WOR	S		
				V		Su = 1250 psf
			WOR	S		
		-80				MARINE CLAY
B			WOR	S		
				V		Su = 1300 psf
			WOR	S		
		-90				
			WOR	S		
				S		
	105.0		WOR		BORING TERMINATED AT 105.0 FT	

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-2
PROJECT: MASS LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 1 OF 2
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO.: V81621
BORING CONTRACTOR: AYERS AND AYERS, INC.	DRILL: CME-55	ELEVATION: 6.8±
WATER LEVEL DATA	DRIVE SAMPLER	CASING SIZE: 3½"
DATE / TIME / DEPTH / CAVED	TYPE S.S.	DATE START: 12/23/81
ENCOUNTERED 12/23 / 1:50 / 7.0' / –	DIA. 2" OD	DATE FINISHED: 12/24/81
AFTER CASING PULLED 12/24 / 9:00 / 10.5' / 11.0'	WT. 140#	DRILLER: C. JAMERSON
4 DAY READING 12/28 / 1:00 / DRY / 4.0'	FALL 30"	INSPECTOR: J. MOSLEHI

STRATUM	DEPTH FT.	ELEV. 6.8	BLOWS ON SAMPLE SPOON, PER 6"	SYMBOL	IDENTIFICATION	REMARKS
			3+5+6	S	FINE TO COARSE SAND FILL TRACE SILT WITH SHELL FRAGMENTS, MOIST - TAN (SP)	
			6+12+10	S		
			2+3+3	S	do, WET	
		0				
			2+3+3	S	do, FINE SAND, WET - GRAY	
			2+1+2	S		
	12.0				CLAY FILL, TRACE FINE SAND WITH SHELL FRAGMENTS, MOIST - DARK GRAY (CH)	
	15.0		1+4+7	S	FINE TO MEDIUM SAND FILL, TRACE SILT WITH SHELL FRAGMENTS, MOIST - DARK GRAY (SP)	
		-10				FILL
			2+4+7	S		
			1+9+7	S	do, FINE TO COARSE SAND, WET - TAN AND GRAY	
		-20				
			8+6+7	S		
			3+3+5	S		Tube pressed 24" Recovery = 0"
		-30				
	38.0					
			4+3+4	S	FINE TO COARSE SAND FILL, SOME SILTY CLAY WITH SHELL FRAGMENTS, MOIST - GRAY (SC)	Tube Pressed 24" Recovery = 24"
				3	do, INTERBEDDED CLAY	
			5+2+4	S	do, WITH FINE GRAVEL	
		-40				
			4+4+6	S		
			4+4+3	S		
	57.0	-50				
			4+3+5	S	FINE TO COARSE SAND FILL, TRACE SILT WET - BROWN (SP)	
			3+5+4	S	do, BROWN AND GRAY	

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-2
PROJECT: WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 2 OF 2
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO.: V81621
BORING CONTRACTOR: AYERS AND AYERS, INC.		ELEVATION: 6.8'

	DEPTH FT.	ELEV.	BLOWS ON SAMPLE SPOON PER 6"	SYMBOL	IDENTIFICATION	REMARKS
A	67.0	-60			BROWN AND GRAY FINE TO COARSE SAND FILL, TRACE SILT, WET - BROWN (SP)	FILL
			1+2+3	S	CLAY, TRACE FINE SAND, MOIST - GRAY (CH)	
				3"	do, SHELL FRAGMENTS	Tube Pressed 24" Recovery = 24"
			WOR+2	S		
		-70				
			WOR	S	do, DARK GRAY	MARINE CLAY
B						
			WOR	S		
		-80				
				3"	do, NO FINE SAND OR SHELL FRAGMENTS	Tube Pressed 24" Recovery = 18"
			WOR	S		
		-90				
			WOR	S		
	105.0		WOR	S		
					BORING TERMINATED AT 105.0 FT	

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-3
PROJECT: WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 1 OF 2
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO. V81621
BORING CONTRACTOR: AYERS AND AYERS, INC.	DRILL: CME-55	ELEVATION: 8.6±
WATER LEVEL DATA	DRIVE SAMPLER	CASING SIZE: 3½"
DATE / TIME / DEPTH / CAVED	TYPE: S.S.	DATE START: 12/24/81
ENCOUNTERED: 12/24 / 9:00 / / -	DIA.: 2" OD	DATE FINISHED: 12/28/81
AFTER CASING PULLED: 12/28 / 2:00 / DRY / 4.0"	WT.: 140#	DRILLER: C. JANERSON
24 HR. READING: 12/29 / 12:30 / DRY / 3.5"	FALL: 30"	INSPECTOR: J. MOSLEHI

STRATUM	DEPTH FT.	ELEV.	BLOWS ON SAMPLE SPOON, PER 6"	SYMBOL	IDENTIFICATION	REMARKS
			6+5+8	S	FINE TO COARSE SAND FILL, TRACE SILT, MOIST - GRAY (SP)	
			7+7+7	S		
	4.0		1+2+4	S	FINE TO MEDIUM SAND FILL, SOME SILTY CLAY WITH SHELL FRAGMENTS, MOIST - VARICOLORED (SC)	
	7.0		4+9+17	S		
		0	8+8+11	S	FINE TO COARSE SAND FILL, TRACE SILT WITH SHELL FRAGMENTS, WET - DARK GRAY (SP-SM)	
			9+8+2	S		FILL
A		-10	4+4+6	S	do, WITH GRAVEL	
			4+3+6	S	FINE TO COARSE SAND FILL, TRACE SILT, WET - DARK GRAY (SP)	
	29.0	-20	4+2+1	S	FINE TO COARSE SILTY SAND WITH CLAY LENSES, MOIST - DARK GRAY (SM)	
	32.0					
			1+1+1	S	CLAY, TRACE FINE SAND WITH SHELL FRAGMENTS, MOIST - DARK GRAY (CH)	
		-30	WOR+1+1	S		MARINE CLAY
B				3"	do, NO FINE SAND OR SHELL FRAGMENTS	Tube Pressed 24" Recovery = 24"
			WOR+1	S		
		-40	WOR+1	S		
			WOR	S		
		-50	WOR	S		
				3"		Tube Pressed 24" Recovery = 24"

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-3
PROJECT: WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 2 OF 2
CLIENT: CORPS OF ENGINEERS NORFOLK, VIRGINIA		JOB NO.: V81621
BORING CONTRACTOR: AYERS AND AYERS, INC.		ELEVATION: 8.6±

	DEPTH FT.	ELEV.	BLOWS ON SAMPLE SPOON PER 6"	SYMBOL	IDENTIFICATION	REMARKS
			WOR	S	CLAY, TRACE FINE SAND WITH SHELL FRAGMENTS, MOIST - DARK GRAY (CH)	
		-60				
			WOR	S		
			WOR	S		
		-70				
			WOR	S		MARINE CLAY
B				3"	do, NO FINE SAND	Tube pressed 24" Recovery = 24"
			WOR	S		
		-80				
			WOR	S	do, NO SHELL FRAGMENTS	
			WOR	S		
	97.0					
		-90			SILTY CLAY, TRACE FINE SAND WITH MICA AND WOOD, MOIST - DARK GRAY (CL)	
	100.0		WOR+1+4	S		
					BORING TERMINATED AT 100.0 FT	

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-4
PROJECT: WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 1 OF 2
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO.: 81621
BORING CONTRACTOR: AYERS AND AYERS, INC.	DRILL: CME-55	ELEVATION: 8.5±
WATER LEVEL DATA	DRIVE SAMPLER	CASING SIZE: 24"
DATE TIME DEPTH CAVED	TYPE S.S.	DATE START: 1-4-82
ENCOUNTERED 1-4 10:35 9.0' –	DIA. 2" OD	DATE FINISHED: 1-4-82
AFTER CASING PULLED 1-4 4:40 DRY 1.2'	WT. 140#	DRILLER: R. AYERS
HR. READING 1-5 3:50 DRY 1.2'	FALL 30"	INSPECTOR: C. ADAMS

STRATUM	DEPTH FT.	ELEV.	BLOWS ON SAMPLE SPOON, PER 6"	SYMBOL	IDENTIFICATION	REMARKS
A		0	6+10+15	S	FINE TO MEDIUM SAND FILL, SOME SILT WITH SHELL FRAGMENTS, MOIST - TAN (SM)	
			10+17+25	S		
			12+24+25	S	do, TRACE SILT	
		-10	15+17+22	S		
			20+12+12	S	do, FINE SILTY SAND, WITH SHELL FRAGMENTS WET - LIGHT GREEN	FILL
			1+2+1	S		
	19.0					
			5+6+8	S	FINE TO MEDIUM SAND, TRACE SILT, WET - GRAY (SP)	
		-20	6+8+4	S		
	29.0					
B			1+1+1	S	CLAY, TRACE FINE SAND, WET - DARK GRAY (CH)	
				V		Su = 450 psf
			1+1+1	S		
		-30	WOR	S		
			WOR	S		MARINE CLAY
		-40	WOR	S		
			WOR	S		
		-50		V		Su = 640 psf
			WOR	S		
			WOR	S		

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-4
PROJECT WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO 2 OF 2
CLIENT CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO : VB1621
BORING CONTRACTOR [illegible]		ELEVATION [illegible]

DEPTH FT.	ELEV	BLOWS ON SAMPLE SPOON, PER 6"	SYMBOL	IDENTIFICATION	REMARKS
	-60				
		WOR	S	CLAY, TRACE FINE SAND, WET - DARK GRAY (CH)	
		WOR	S		
	-70				
		WOR	S		MARINE CLAY
B					
			V		Su = 750 psf
		WOR	S		
	-80				
		WOR	S		
		WOR	S		
97.0					
	-90			CLAY, TRACE FINE SAND, WITH ORGANIC MATTER, MOIST - DARK GRAY (CH)	
		2+3+5	S		
				BORING TERMINATED AT 100.0 FT	

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-5
PROJECT: WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 1 OF 2
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO.: V81621
BORING CONTRACTOR: AYERS AND AYERS, INC.	DRILL: CME-55	ELEVATION: 7.9±
WATER LEVEL DATA	DRIVE SAMPLER	CASING SIZE: 3½"
	TYPE: S.S.	DATE START: 12/28/81
	DIA.: 2" OD	DATE FINISHED: 12/29/81
	WT.: 140#	DRILLER: R. AYERS
	FALL: 30"	INSPECTOR: J. MOSLEHI

WATER LEVEL DATA	DATE	TIME	DEPTH	CAVED
ENCOUNTERED	12/28	3:05	8.0'	-
AFTER CASING PULLED	12/29	11:00	DRY	5.0'
24 HR. READING	12/30	8:00	DRY	4.5'

STRATUM	DEPTH FT.	ELEV. 7.9±	BLOWS ON SAMPLER SPOON, PER 6"	SYMBOL	IDENTIFICATION	REMARKS
			7+12+16	S	FINE TO COARSE SAND FILL, TRACE SILT WITH SHELL FRAGMENTS, MOIST - GRAY (SP)	
			9+14+20	S		
			14+26+24	S		
		0	12+16+21	S	do, WET	
A			8+13+17	S	do, FINE TO MEDIUM - GRAY-GREEN	
			4+1+4	S		
		-10				
			1+2+6	S	do, SOME SILT - GRAY	FILL
	23.0					
			1+1+1	S	CLAY, SOME FINE SAND WITH SHELL FRAGMENTS, MOIST - DARK GRAY (CL)	
	20.0	-20				
			WOR+1	S	CLAY, TRACE FINE SAND WITH SHELL FRAGMENTS, MOIST - DARK GRAY (CH)	
			1+WOR+1	S		MARINE CLAY
		-30				
B			WOR+1	S		
				3"	do, NO FINE SAND OR SHELL FRAGMENTS	Tube Pressed 24" Recovery = 24"
		-40	WOR+1+2	S		
			WOR	S		
			WOR	S		
		-50				
			WOR	S		
			WOR	S		

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-5
PROJECT: WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 2 OF 2
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO.: V81621
BORING CONTRACTOR: AYERS AND AYERS, INC.		ELEVATION: 7.9±

DEPTH FT.	ELEV.	BLOWS ON SAMPLE SPOON, PER 6"	SYMBOL	IDENTIFICATION	REMARKS
	-60				
			3"	CLAY, TRACE FINE SAND WITH SHELL FRAGMENTS - GRAY (CH)	Tube Pressed 24" Recovery = 24"
		WOR	S		
		WOR	S		
	-70				
		WOR	S		MARINE CLAY
			3"	do, NO SHELL FRAGMENTS	Tube Pressed 24" Recovery = 24"
		WOR	S		
	-80				
		WOR	S		
		WOR	S		
	-90				
		WOR	S		
				BORING TERMINATED AT 100.0 FT	

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-6
PROJECT: WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 1 OF 2
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO.: V81621
BORING CONTRACTOR: AYERS AND AYERS, INC.	DRILL: CME-55	ELEVATION: 7.0±
WATER LEVEL DATA	DRIVE SAMPLER	CASING SIZE: 3½"
DATE / TIME / DEPTH / CAVED	TYPE: S.S.	DATE START: 12/29/81
ENCOUNTERED: 12/29 / 12:40 / 5.0' / -	DIA.: 2" OD	DATE FINISHED: 12/30/81
AFTER CASING PULLED: 12/30 / 10:30 / DRY / 4.0'	WT.: 140#	DRILLER: R. AYERS
24 HR. READING: 12/31 / 8:30 / DRY / 3.5'	FALL: 30"	INSPECTOR: J. MOSLEHI

STRATUM	DEPTH FT.	ELEV. 7.0±	BLOWS ON SAMPLE SPOON, PER 6"	SYMBOL	IDENTIFICATION	REMARKS
			1+10+12	S	FINE TO COARSE SAND, SOME SILT WITH SHELL FRAGMENTS AND GRAVEL, MOIST - TAN (SM)	
			7+13+13	S		
			7+19+23	S	do, TRACE SILT, WET	
		0				
			13+18+25	S		
			8+9+18	S	do, FINE, wet - GRAY-GREEN	
A						
			8+9+8	S	do, TRACE SILT, WET - GRAY	FILL
		-10				
			5+2+4	S		
			6+4+5	S		
		-20				
	28.0					
			1+1+1	S	CLAY, TRACE FINE SAND WITH SHELL FRAGMENTS, MOIST - GRAY (CH)	
				3"		Tube Pressed 24" Recovery = 24"
		-30	WOR	S		
			WOR	S		
B						
			WOR	S		MARINE CLAY
		-40				
			WOR+1	S	do, TRACE FINE SAND, MOIST - GREEN-GRAY	
			WOR	S		
		-50				
			WOR	S	do, GRAY	
			WOR	S		

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-6
PROJECT: WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 2 OF 2
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO.: 981621
BORING CONTRACTOR: AYERS AND AYERS, INC.		ELEVATION: 7.0'

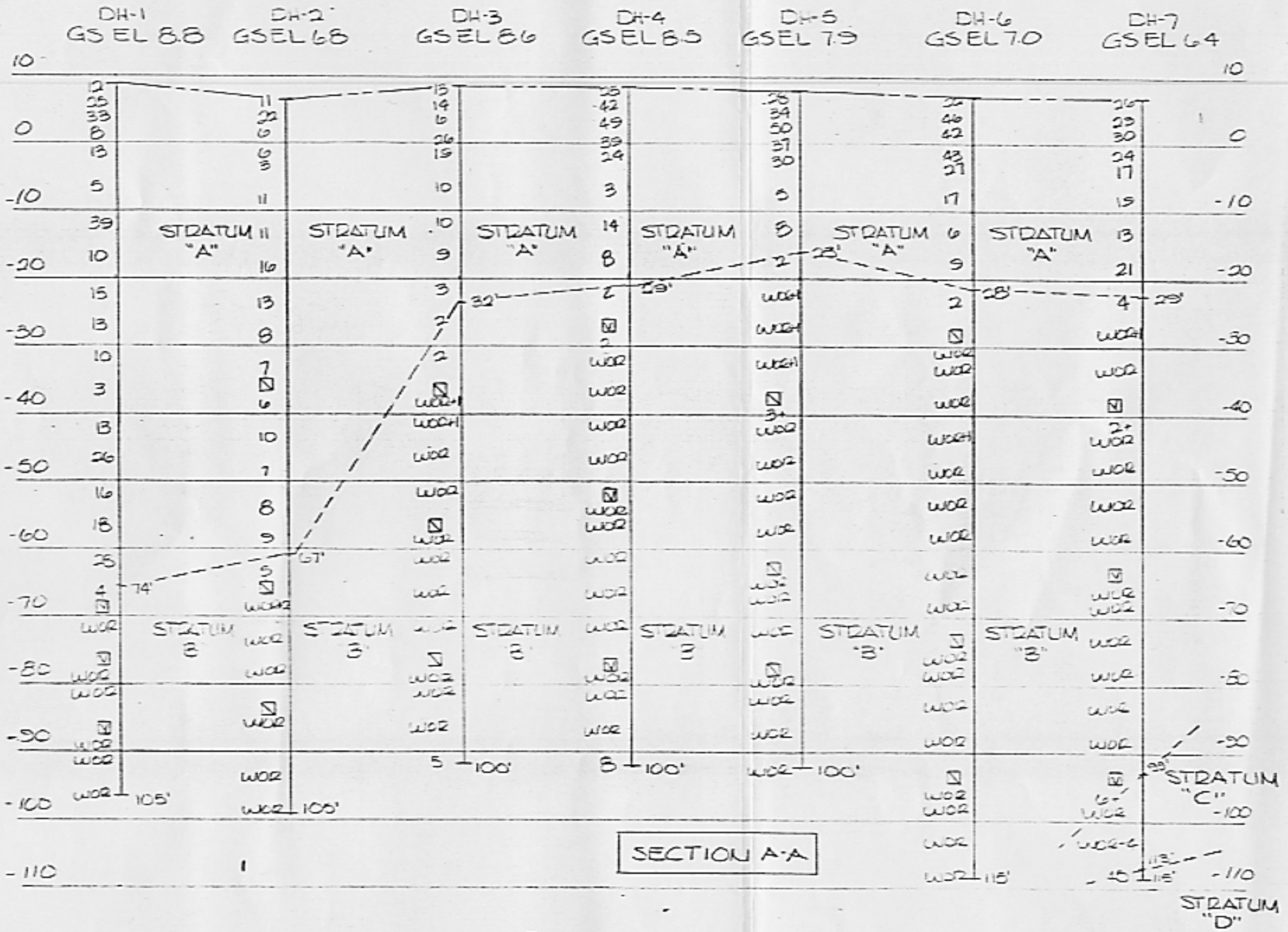
DEPTH FT.	ELEV.	BLOWS ON SAMPLE SPOON PER 6"	SYMBOL	IDENTIFICATION	REMARKS
				CLAY, TRACE FINE SAND, MOIST - GREEN-GRAY (CH)	
	-60				
		WOR	S		
		WOR	S		
	-70				
			3"	do, NO SHELL FRAGMENTS, GRAY	Tube Pressed 24" Recovery = 24"
		WOR	S		
		WOR	S		MARINE CLAY
	-80				
		WOR	S		
		WOR	S	do, WITH SHELL FRAGMENTS	
	-90				
			3"		Tube Pressed 24" Recovery = 24"
		WOR	S		
		WOR	S		
	-100				
		WOR	S	do, SOME FINE SAND	
111.0					
				FINE CLAYEY SAND, MOIST - DARK GRAY (SC)	
115.0		WOR	S		
				BORING TERMINATED AT 115.0 FT	

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-7
PROJECT: WEST LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 1 OF 1
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO. V8162J
BORING CONTRACTOR: AYERS AND AYERS, INC.	DRILL: CME-55	ELEVATION: 6.4±
WATER LEVEL DATA	DRIVE SAMPLER	CASING SIZE: 2½"
DATE / TIME / DEPTH / CAVED	TYPE: S.S.	DATE START: 12/30/81
ENCOUNTERED: 12/30 / 10:45 / 5.0' / –	DIA.: 2" OD	DATE FINISHED: 1/5/82
AFTER CASING PULLED: 1/5 / 10:08 / DRY / 1.7'	WT.: 140 #	DRILLER: R. AYERS
___HR. READING	FALL: 30"	INSPECTOR: J. MOSLEHI

STRATUM	DEPTH FT.	ELEV. 6.4±	BLOWS ON SAMPLING SPOON PER 6"	SYMBOL	IDENTIFICATION	REMARKS
			4+11+15	S	FINE TO COARSE SAND, TRACE SILT WITH SHELL FRAGMENTS, MOIST – TAN (SP)	
			12+12+17	S		
			9+16+14	S	do, WET	
		0				
			9+11+13	S		
			10+9+8	S	do, FINE SAND	
	13.0					
A			2+7+12	S	FINE SAND, SOME SILT WITH SHELL FRAGMENTS, WET – TAN (SM)	FILL
		-10				
			5+6+7	S		
	23.0					
			6+10+11	S	FINE TO COARSE SAND, TRACE SILT WITH SHELL FRAGMENTS, WET – GRAY (SP)	
		-20				
	29.0					
			1+2+2	S	CLAY, TRACE FINE SAND WITH SHELL FRAGMENTS, MOIST – DARK GRAY (CH)	
			1+WOR+1	S	do, FINE TO COARSE SAND LENSES, ODOR	
		-30				
			WOR	S		MARINE CLAY
B						
				V		Su = 475 psf
		-40	1+1+1	S		
			WOR	S	do, GREEN-GRAY	
			WOR	S		
		-50				
			WOR	S		
			WOR	S		

SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS	TEST BORING LOG	BORING NO.: DH-7
PROJECT: MISS LEVEE ALIGNMENT STUDY, CRANEY ISLAND, NORFOLK		SHEET NO. 2 OF 2
CLIENT: CORPS OF ENGINEERS, NORFOLK, VIRGINIA		JOB NO.: VB1621
BORING CONTRACTOR: AYERS AND AYERS, INC.		ELEVATION: 6.4±

	DEPTH FT.	EL.EV.	BLOWS ON SAMPLE SPOON PER 6"	SYMBOL	IDENTIFICATION	REMARKS
		-60				
				V		Su = 600 psf
			WOR	S	CLAY, TRACE FINE SAND, MOIST - DARK GRAY-GREEN (CH)	
			WOR	S		
		-70				
			WOR	S	do, GRAY	MARINE CLAY
B			WOR	S	do, WITH SHELL FRAGMENTS	
		-80				
			WOR	S		
			WOR	S		
		-90				
	99.0					
				V	FINE SANDY CLAY, MOIST - DARK GRAY (CL)	Su = 3450 psf
			2+2+4	S		
	104.0		WOR	S	FINE TO MEDIUM SAND, TRACE CLAY, MOIST - GRAY (SC)	TRANSITION ZONE
C		-100				
			WOR+4	S	FINE SANDY CLAY, WITH WOOD FRAGMENTS, MOIST - DARK GRAY (CL)	
	113.0					
D	115.0		9+18+27	S	FINE TO MEDIUM SAND, TRACE SILT, WET - GRAY-GREEN (SM)	YORKTOWN FORMATION
					BORING TERMINATED AT 115.0 FT	



SCALE: 1" = 400' 0 400 800 HORIZ.

SCALE: 1" = 10' 0 10 20 VERT.

GENERAL NOTES

1. NUMBERS TO THE LEFT OF THE BORING COLUMNS INDICATE NUMBER OF BL
   TO DRIVE A 2 INCH O.D., 1-3/8 INCH I.D. SAMPLING SPOON ONE FOOT
   140 POUND HAMMER FALLING 30 INCHES, ACCORDING TO ASTM D-1586.
2. G. S. = GROUND SURFACE ☒ UNDISTURBED TU
   WOR = WEIGHT OF RODS ☑ VANE SHEAR TES
3. TEST BORINGS DRILLED BY AYERS AND AYERS, INC. IN DECEMBER 1981
   JANUARY 1982.
4. THIS DRAWING CONTAINS INTERPRETATION OF TEST BORING DATA AND SH
   USED AS PART OF THE CONTRACT DOCUMENTS.
5. THESE PROFILES WERE DEVELOPED BY INTERPOLATION BETWEEN WIDELY S
   ONLY AT THE BORING LOCATIONS SHOULD THEY BE CONSIDERED AN AP
   ACCURATE REPRESENTATIVE AND THEN ONLY TO THE DEGREE IMPLIED BY
   THE BORING LOGS.
6. TEST BORINGS INSPECTED BY SCHNABEL ENGINEERING ASSOCIATES.
7. LOCATIONS AS SHOWN ON SHEET 1.

STRATA DESCRIPTIONS

STRATUM A: TAN, BROWN OR GRAY FINE TO COARSE SAND FILL WITH VARIAB
SILT AND CLAY (SP, SM AND SC); (N = 3 TO 50)

STRATUM B: GRAY CLAY, TRACE FINE SAND WITH SHELL FRAGMENTS (CH); (N

STRATUM C: DARK GRAY FINE SANDY CLAY WITH WOOD FRAGMENTS (CL) AND
MEDIUM SAND, TRACE CLAY (SC); (N = WOR TO 6)

STRATUM D: GRAY-GREEN FINE TO MEDIUM SAND, TRACE SILT (SM); (N =

Below D

1

60m

SCHNABEL ENGINEERING A
CONSULTING ENGINEERS SOIL MECHANICS AND
BETHESDA, MARYLAND : RICHMOND, V

LEVEE ADDITION COM

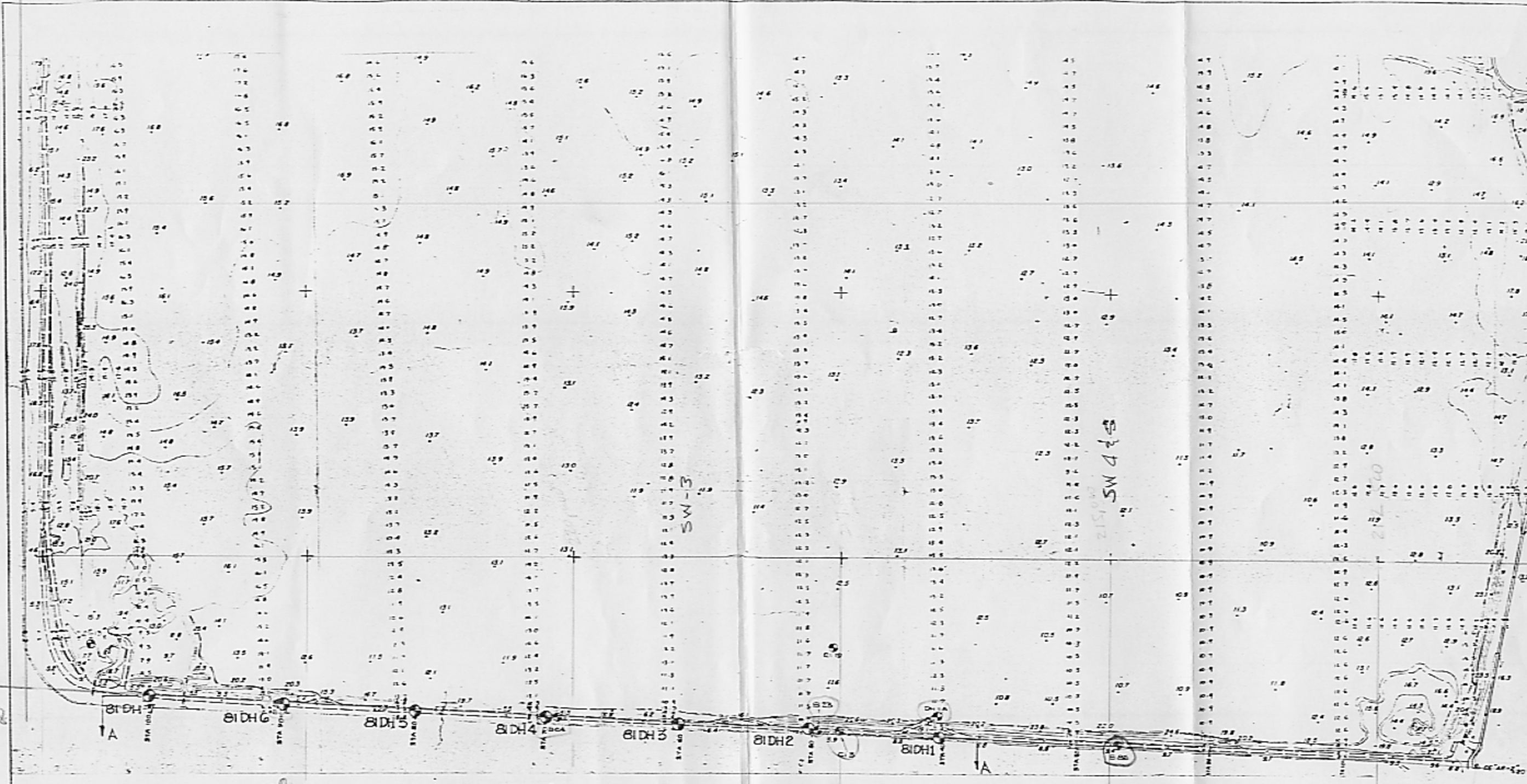
NORFOLK, VIRGINIA

ESTIMATED SUBSURFACE PROFILES

SCALE AS S-0

DRAWN BY DSO

DRWG NO VB 621



0 400 800
SCALE: 1" = 400'

LEGEND

- TEST BORINGS DRILLED PREVIOUSLY
- 81DH1 TEST BORINGS DRILLED THIS STUDY
- 12.4 GROUND SURFACE ELEVATIONS

N

SCHNABEL ENGINEERING ASS
CONSULTING ENGINEERS, SOIL MECHANICS AND FOU
BETHESDA, MARYLAND - RICHMOND, VIRGINIA

LEVEE ADDITION, CRANEY
NORFOLK, VIRGIN

TEST BORING LOCATION PLAN

SCALE: AS SHOWN
DRAWN BY: DPO
JOB NO: V81621